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D'ESPINE'S AND ALLIED SIGNS IN CHILDHOOD*

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BOSTON

About six years ago, finding that there was considerable difference of opinion as to what constituted D'Espine's sign, I looked up D'Espine's original descriptions of his "sign" and found them to be as follows:

In one article[1] he said that he had called attention briefly to this method of diagnosis in 1889,[2] and that Professor Brouardel, in a communication made for him at the session of the Academy of Nov. 8, 1904, said:

"The first signs of bronchial adenopathy are furnished exclusively by the auscultation of the voice, and are found almost always in the immediate neighborhood of the vertebral column between the seventh cervical vertebra and the first dorsal vertebra, sometimes in the fossa 'sus-épineuse,' sometimes in the interscapular space. They consist in a quality (timbre) added to the voice, which may be called whispering (chuchotement) in the first stage and bronchophony in a more advanced stage."

He then goes on to say that:

"It is most important to distinguish the exaggerated normal voice sound from the bronchial voice sound."

He says that:

"The tracheal sound is heard normally through the seventh cervical spine, where it ceases abruptly. In bronchial adenopathy the bronchial sound extends downward into the space between the seventh cervical and the fourth or fifth dorsal spines. This space corresponds to the last portion of the trachea and the bifurcation of the bronchi, which is at the level of the third dorsal vertebra."

He recommends the use of "333," spoken in French, for making the test, and says:

"If auscultation of the loud voice or cry gives no result, the child should be made to speak in a low voice."

A sound is then heard which he designates as "whispering (chuchotement)" "This sound has the same value as bronchophony."

* Received for publication, July 31, 1922.

1. D'Espine: The Early Diagnosis of Tuberculosis of the Bronchial Glands in Children, Bull. de l'acad. de méd. **57**:167, 1907.

2. Manual of Picot and D'Espine, Ed. 4, 1889.

In a later communication [3] he says that:

"The sign is most obvious when the child is made to speak or count in a low voice. The voice is then accompanied by an added whispering sound localized to one or two vertebrae, or possibly extending to the fourth or fifth. A bronchial quality to the respiration at the same place has the same diagnostic value as the whispered sound. It is necessary to be content with this, if the child is too young to speak, but the bronchial breathing is a sign of enlargement already more considerable and more extensive. It is the same with vertebral percussion."

A number of articles on D'Espine's sign have been published since that time. It is evident that their authors have not read D'Espine's original descriptions of his "sign," have not understood it, are using the term to mean something different from what he meant in his description, or that my translation of his articles is wrong. It was even suggested a year ago that D'Espine had changed his mind as to what he meant by his "sign." In order to be sure that my translation was not incorrect I sent a copy of my paper [4] to Dr. Charles Greene Cumston, an American, but also a colleague of D'Espine at the University of Geneva. He writes, "I have carefully gone over your interpretation of Professor D'Espine's sign and find it absolutely correct." I then wrote to D'Espine to find out if he had changed his mind. He answered [5] that the original description is "Aussi exacte aujourd' hui." It seems evident, therefore, that most men have not read D'Espine's original articles and are using the term "D'Espine's sign" very loosely.

The sign to which D'Espine originally called attention is, therefore, a whispering sound following the spoken voice and heard over the spinous processes. No such sound is heard normally. He believed this to be the earliest sign of enlargement of the tracheobronchial lymph nodes. He also believed that the bronchial character of the spoken voice did not normally extend below the seventh cervical spine and that extension of the bronchial sound below this point was evidence of an enlargement of the tracheobronchial lymph nodes. He considered that the extension of the bronchial voice below the seventh cervical spine was always a later sign than the addition of the whispering sound to the spoken voice and that it meant a more advanced process. He paid little attention to the character of the whispered voice (meaning by this a whisper, not the whispering sound heard after the spoken voice) and believed that extension of the bronchial respiratory sound and of dulness on percussion below the seventh cervical spine were still later manifestations and that they signified much more marked changes. Incidentally, he warns against mistaking an unusually loud

3. D'Espine: Brit. M. J. **2**:1136, 1910.
4. Morse, J. L.: Am. J. Dis. Child. **11**:276 (April) 1916.
5. Aug. 13, 1921.

or deep voice for bronchophony, and states that sometimes it is impossible to determine anything from the voice itself, because of its peculiar character or the thinness of the chest wall.

In view of the great differences of opinion as to terminology, it seemed worth while to examine a series of children to determine, if possible, whether the addition of a whispering sound to the spoken voice is a normal or usual condition or not, whether this whispering sound is always added to the spoken voice before any other changes occur in the voice or respiration and where the change from the bronchial to the vesicular character of the spoken voice, whispered voice and respiration normally occurs. It also seemed worth while to try to determine whether the change from bronchial to vesicular occurred first in the spoken or the whispered voice, whether the change occurred earlier or later in the character of the respiration than in that of the voice, and the relation of dulness over the spinous processes and between the scapulae to these changes.

One hundred and eighteen patients between the ages of 2 and 14 years were studied. Seventy-five of these were between 4 and 9 years of age. Sixty-eight were boys and fifty were girls. They were consecutive cases, except that a child was occasionally missed on account of hurry or because it would not cooperate. Thirty-three of these children were brought in simply for examination and general advice and no evidences of disease were found in them. Eighteen were classified as delicate children, while thirteen had various disturbances of digestion. Six had nasopharyngitis, four had chronic disease of the tonsils and three had bronchitis. The diagnoses in the others were almost all different, not more than two or three having the same disease. The presence or absence of a whispering sound after the spoken voice was noted in each instance. In determining this point, it is necessary that the child speak sharply and that it does not make a whispering sound after speaking. "One" and "Oh" are the best words to use. The points where the spoken voice, whispered voice, and respiration changed from bronchial to vesicular were also always determined. It is evident that this is possible only when a stethoscope with a small bell is used. The point where dulness on percussion began and the presence or absence of interscapular dulness were also determined. The point of change in the character of the spoken and whispered voice and in the respiration was always definite, but there was not the same certainty about the change in the percussion note, and the findings on this point are, therefore, not quite as reliable.

In eighty-eight cases, or nearly 75 per cent., there was no whispered sound after the spoken voice; in twenty-four cases it was heard through the seventh cervical spine, and in six cases below this point as well.

It seems evident, therefore, that a whispered sound after the spoken voice is not the usual condition and is probably abnormal.

The change from bronchial to vesicular in the spoken voice took place between the seventh cervical and first dorsal spines in ninety cases and above it in nine. There was no bronchial voice anywhere in nine cases, and in four cases the character of the sound was everywhere the same and undeterminable. That is, in only six cases, or 5 per cent., did the bronchial voice extend below the seventh cervical spine.

The change from a bronchial to a vesicular whisper took place between the seventh cervical and first dorsal spines in eighty-seven instances. Three of the younger children refused to whisper. The whisper was not bronchial anywhere in five cases and the character was everywhere the same and undeterminable in one case. That is, the bronchial whisper was heard below the seventh cervical spine in twenty-two cases, or about 19 per cent.

The change from bronchial to vesicular respiration occurred between the seventh cervical and first dorsal spines in ninety-seven instances. It occurred above this point in two, in one the character of the respiration was everywhere the same and undeterminable and in three it was everywhere vesicular. In only fifteen, or less than 13 per cent., did the bronchial respiration extend below the seventh cervical spine.

The spinal dulness stopped at the seventh cervical spine in ninety-five cases and above it in one. In one other case no dulness could be made out in the neck. In twenty-one cases, or 18 per cent., therefore, there was dulness below the seventh cervical spine. Interscapular dulness was not found in any case.

In fifty-four cases there was no whispering sound after the spoken voice, the change from bronchial to vesicular in the spoken and whispered voices and in the respiration occurred at the junction of the seventh cervical and first dorsal spines, there was no dulness below the seventh cervical spine and no interscapular dulness. In eighteen others there was no whispering sound after the voice and the change from the bronchial to the vesicular sound in the spoken or whispered voice or in the dulness occurred above the seventh cervical spine. It seems fair to conclude, therefore, that when there is no whispering sound after the spoken voice, the bronchial voice, whisper and respiration and the spinal dulness do not extend below the seventh cervical spine, and there is no interscapular dulness, conditions are normal. It seems probable that they are not normal when the bronchial voice, bronchial whisper, bronchial respiration and spinal dulness extend below the seventh cervical spine. They are certainly abnormal when there is interscapular dulness.

The whispering sound after the spoken voice, which will hereafter be referred to as "D'Espine's sign," was present in sixteen instances through the seventh cervical spine and in one through the third dorsal spine, when the changes in the spoken and whispered voices, the respiration and the dulness occurred at the normal level. The diagnoses in these cases were: No disease in four cases; delicate child in five cases; asthma in two cases; cervical adenitis, indigestion, enuresis, epistaxis, hip disease and chronic disease of the tonsils, each in one case. There were twenty-nine instances in which the bronchial voice, whisper or respiration or the spinal dulness extended lower than the seventh cervical spine. In thirteen of these cases D'Espine's sign was also present, in the other sixteen cases it was not. The diagnoses in these twenty-nine cases were: No disease in five cases; delicate child in three cases; cervical adenitis, nasopharyngitis, chronic disease of the tonsils, tracheobronchial adenitis and bronchitis, each in two cases; adenoids, chronic heart disease, chronic appendicitis, congenital heart disease, tracheitis, eczema, cretinism, myocarditis, general adenitis and orthostatic albuminuria, each in one case. These abnormal signs and D'Espine's sign were at the same level in six cases, while they extended lower than D'Espine's sign in seven instances. D'Espine's sign never extended lower than the other signs, except when it was the only abnormality. The presence of D'Espine's sign in seventeen instances without any other abnormal changes would seem to corroborate D'Espine's contention that it is the earliest evidence of abnormalities in the tracheobronchial region and that abnormalities can, therefore, be discovered by it before they can by other means. If this is so, it would seem reasonable to believe that it would persist after the appearance of other signs, presumably indicative of more serious pathologic changes. It was present in thirteen instances in which there were other signs, but it was absent in sixteen cases. That is, it either does not always persist after the development of other signs or the other signs may appear without it. Either explanation is possible. It seems more reasonable to suppose, however, that the other signs may appear first, rather than that it disappears after their appearance. If so, D'Espine's contention that it is always the earliest sign of pathologic changes in the tracheobronchial region is erroneous. This detracts but little from its value, however, because in many, and, perhaps, most, instances it evidently does appear before any other signs and does furnish evidence of abnormalities which can be obtained in no other way.

The spoken and whispered voices were both bronchial below the seventh cervical spine in six instances. In these cases the change from bronchial to vesicular respiration and from dulness to a normal percussion note occurred at the same level as the change in the spoken and

whispered voices. In no instance did the bronchial voice extend below the seventh cervical spine when the bronchial whisper did not extend below this level. In thirteen instances, however, the change in the whispered voice from bronchial to vesicular occurred below the seventh cervical spine when the change in the spoken voice was at the normal level. The change in the character of the respiration from bronchial to vesicular was lower than normal in six, and the dulness extended below the normal level in six of these cases. In one instance the extension of bronchial respiration through the second dorsal spine was the only abnormal sign. An extension of the bronchial sound of the whispered voice below the seventh cervical spine is more common, therefore, than that of the spoken voice. If the bronchial sound of the spoken voice is heard lower than normal so also is that of the whispered voice. It seems probable, therefore, that a change in the whispered voice takes place with slighter pathological changes in the tracheobronchial region than can be recognized by the spoken voice. The value of the change in the character of the respiration apparently lies about midway between those of the spoken and whispered voices.

Dulness on percussion over the spinous processes always extended below the seventh cervical spine when both the bronchial, spoken and whispered voices were below the normal level and in about one-half of the cases in which the bronchial whispered voice was below the normal level. It was usually at the same level as the change in the whispered voice. In two instances, however, it was lower than normal when D'Espine's sign was the only other abnormality, and in four it was the only abnormal sign. The low limit of dulness was the first dorsal in four cases, second dorsal in eleven cases, and third dorsal spine in six instances. It would seem from these figures as if the change in the percussion note is more delicate than that in the respiratory sound and that at times it may reveal pathologic changes not detectable in any other way. This may be the case, but it is somewhat doubtful, because it is more difficult to be certain of slight changes in the percussion note than in the spoken or whispered voices or in the respiration. Interscapular dulness is a relatively late sign of pathologic changes in the tracheobronchial region and, when present, signifies that such changes are considerable.

SUMMARY

The sign to which D'Espine called especial attention is a whispering sound heard after the spoken voice when the bell of the stethoscope is placed over the spinous processes. This sound is not heard under normal conditions. Normally the bronchial sound of the spoken and whispered voices and of the respiration does not extend below the seventh cervical spine. Dulness on percussion over the spinous processes stops at the same level. Extension of the bronchial sound of the spoken

and whispered voices and of the respiration, as well as of dulness on percussion, below the seventh cervical spine is abnormal and has the same significance as the whispering sound after the spoken voice. The whispering sound after the spoken voice, D'Espine's sign, is often the earliest and only abnormality. It may, however, be absent when one or more of the other signs are present. The whispered voice is a somewhat more delicate test of pathological changes in the tracheo-bronchial region than is the spoken voice. The respiratory sound has an intermediate value. The value of percussion over the spinous processes is about the same as that of the respiratory sound. Interscapular dulness is a late sign and is found only when the pathologic changes are considerable.

A CLINICAL AND CHEMICAL STUDY OF BUTTER SOUP FEEDING IN INFANTS*

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AND
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Since the appearance of Czerny and Kleinschmidt's article in the *Jahrbuch für Kinderheilkunde* for 1918, describing their new butter-flour mixture for infants and their experience in its use, many contributions on the subject have appeared in the German periodicals, particularly the *Jahrbuch für Kinderheilkunde* and the *Zeitschrift für Kinderheilkunde*. The only extensive articles in English are those by Crozer Griffith [1] and by Graeme Mitchell.[2] All, with the exception of one each by Stolte [3] and Zielaskowski,[4] are mainly clinical discussions and report no metabolism observations. Most of these writers give their experience with feeding from twenty to fifty children on this food for varying lengths of time. For the type of children for whom it is indicated there is almost unanimous agreement that the use of the C-K butter-flour mixture brings about rapid and uniform weight gain, improvement in color of the skin and in turgor, deposition of subcutaneous fat, tendency to sleep well, and a generally happy disposition. The stools resemble those of breast fed infants and like them contain a large percent of fat.

Many clinicians recommend its exclusive use for very young, premature or very small infants when artificially fed. Czerny and Kleinschmidt consider that prematures under 1,700 gm. in weight should receive part breast milk. Several others think that young weakly infants should have butter-flour mixture supplemented by breast milk. One author claims to get better results with the butter-flour mixture for children over six months of age than for those under. Some report success in using it for infants who are vomiting, especially infants of the neuropathic type. There is general agreement, however, that in certain cases of eczema its use is indicated, here again with neuropathic children, while in other cases of eczema the condition is aggravated by feeding with butter-flour mixture. Several consider it adapted for

* Received for publication July 26, 1922.

* From the Wards and Laboratories of the Hospital for Sick Children and the Department of Pediatrics, University of Toronto.

1. Griffith, J. P. C.: Arch. Pediat. **38**:412, 1921. Griffith, J. P. C., and Mitchell, A. G.: New York M. J. **114**:137, 1921.
2. Mitchell, A. G.: Arch. Pediat. **38**:414, 1921.
3. Stolte, K.: Jahrb. f. Kinderh. **89**:161, 1919.
4. Zielaskowski: Jahrb. f. Kinderh. **97**:330, 1922.

long continued use, one having used it for 150 days continuously. One author reports good results with this food in intercurrent infections, another in digestive disturbances and infections when there is general weight gain. Czerny and Kleinschmidt direct its use with part breast milk in reparation from acute digestive disturbances. All seem to be agreed that it is not to be used in acute digestive disturbances with great weight loss or in decomposition or when tolerance has been lowered by infection. There is more difference of opinion regarding its use in atrophy. Several clinicians consider it not indicated, though one claims good results from its use in atrophy, parenteral infections and long continued dyspepsia. Nearly all charge the failures reported with this food to its use in too severe cases of food intolerance, and most seem to feel that it is too difficult a question for any but pediatrists to decide when its use is indicated.

One author states that the butter-flour mixture gives no protection against rickets or infection; another that he has received the impression that the symptoms of rickets were worse after the use of this food, while several see no lessening in the symptoms after feeding butter-flour mixture. However, it is admitted that there is, in general, a strong tendency to rickets at present even among breast-fed infants. Stolte claims to have seen no signs of rickets, even no trace of craniotabes, after long continued use of the food.

Edema has not often been observed. When it has, it has been ascribed to an exceptionally high content of sodium chlorid in the butter used. It is also to be considered that the weak and undernourished infants among those fed on this food often show a tendency to edema on any food. The theory of a water retention as explanation of the great weight gain characteristic with this food is generally discredited. The small fluid intake in feeding butter-flour mixture and the common accompaniment of sweating are against such a theory.

One author reports success in a case of constipation when lactose was substituted for dextrose in the food. Margarine was substituted for butter by one investigator who found no ill effects whatever. A case of weight equilibrium after weeks of gaining on the food was reported when the weight curve began to rise again after addition of plasmon to increase the protein content of the food.

It is emphasized that the change to a different food must be made gradually.

The good results obtained so generally with this form of food are variously imputed to the following causes; high fat intake in a form that can be tolerated, thus covering the special need of the young infant for fat; high caloric content; low fluid content of a concentrated food; the relative proportions of fat, carbohydrate and protein resembling those of breast milk; high fat content in relation to high sodium chlorid content; the burning off of volatile fatty acids; the browning of the

flour; and even the change to a gram-positive intestinal flora resembling that characteristic of breast fed infants, resulting from the use of this food.

Stolte [3] and Zielaskowski [4] give results of metabolism observations on several children fed on the C-K butter-flour mixture, to which reference will be made later. They have obtained fat and nitrogen balances and in a few cases carbohydrate and total salt balances, in one only the balances of the various salts. They found in most cases an abnormally low fat retention as per cent. of intake; normal carbohydrate retention; a positive balance of nitrogen but sometimes abnormally low retention; once a low positive salt balance and once a negative balance; and in the one case studied for retention of separate salts a negative calcium and very small phosphorus balance. They ascribe the excessive loss of calcium and phosphorus to an abnormally increased peristalsis in a neuropathic child under the restraint necessitated by the metabolism observation.

Preparation; Composition and Indication.—The original mixture calls for the following ingredients: butter (melted), 7 gm.; flour, 7 gm.; sugar, 5 gm.; water, 100 c.c. Flour and butter are always in equal amounts. The mixture is diluted with milk in the proportion of two-thirds butter-flour to one-third whole milk for children weighing less than 6½ pounds, and three-fifths butter-soup to two-fifths milk for children in a better state of nutrition. Such a food gives from seventy-five to eighty calories per pound. Even though digestion and metabolism are taxed heavily by this, contrasting as it does with the normal requirements of calories for the new-born, of sixty-five for premature babies and forty-five for older children, the food is well borne.

The foundation for recommending this feeding was the idea that the freely added fat could be tolerated better by removing the volatile fatty acids through heating; however, there is little of volatile fatty acids in good fresh butter. On the other hand, the volatile fatty acids from carbohydrate breakdown produced during digestion may disturb the process of fat digestion, more particularly when more fat is present in the food. This accounts for the fact that a digestive disturbance with the feeding runs a particularly serious course, and may easily bring about an irreparable disturbance of metabolism. Therefore, butter-flour feeding is not indicated in cases where there is a digestive or metabolic disturbance, which, however, is difficult to determine beforehand.

After considerable experimentation in the milk laboratory, the following simplified method has been adopted and used exclusively in our series of cases.[5]

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5. We desire to thank Miss Elsie Luckam of the milk laboratory for her help in the modification of the formula.

BUTTER SOUP

Butter	7¼ level teaspoons
Granulated sugar	5¼ level teaspoons
Flour	14¾ level teaspoons
Water	17½ ounces

1. Melt the butter in a sauce pan, over the lowest possible flame, or using an asbestos mat, or until the butter stops foaming and becomes a dark color, usually taking seven minutes.

2. Add flour and sugar, blending thoroughly.

3. Add 17½ ounces of cold water and stir constantly until mixture thickens (usually taking five minutes).

4. Cook in double boiler for thirty minutes.

5. Measure and add boiled water to make 20 ounces. Normal color is light brown.

The caloric value of this butter soup (without addition of milk) is approximately 28 to the ounce. For an infant weighing seven pounds, the following feeding would thus be adopted: butter soup, 14 ounces; whole milk, 7 ounces; 7 feedings. The caloric value of this mixture is approximately 24 to the ounce.

When the stools tended to be loose, the sugar was omitted and ½ to 1 ounce of casein flour was added in order to overcome the excessive fermentation. Little difficulty has been experienced with the preparation of this food in the home.

ANALYSIS OF CASES

Private Cases.—For purposes of analysis, the series has been divided into three classes, viz., (1) new-born; (2) atrophy (marasmus), and (3) difficult feeding cases with no special symptomatology except that they would not thrive.

Series 1. New-Born.—In this series were fifteen cases with no deaths. Every infant did exceptionally well. Many of these babies were put on the diet during the first few days of life when breast milk was not available. The average age, however, at which the babies were put on the diet was approximately 6 weeks, and the average weight 7 pounds 10 ounces. The gain in weight was quite striking, the average being 2¼ pounds per month, while the best gain was 3 pounds and the lowest gain 1½ pounds per month. It will be seen from these figures that the progress was decidedly better than with the average milk and water dilutions, with which one is satisfied with a gain of one pound a month on account of the low tolerance for ordinary dilutions of cow's milk in infants at this age. The average number of calories fed to the infants in this group was 72; the highest, 84 calories per pound, only one infant receiving as low as 50 per pound. The longest period on the diet was five months.

It must be confessed that the great majority of these babies thrived as though they had been breast fed. Their tissue turgor was excellent and none of them showed any tendency to develop clinical rickets, as evidenced by the presence of craniotabes. Their stools were remarkably consistent and of a solid breast fed character. With one exception, they all tended to be constipated, thus requiring small doses of milk of magnesia. Two of these infants during the course of observation developed nasopharyngitis, which under ordinary circumstances affects the babies' progress, but in these two cases there was no appreciable clinical change in the upward progress.

Series 2. Atrophy (Marasmus).—In this group there were eighteen cases with no deaths. The average age and weight were, respectively, 3½ months and 8 pounds. The best gain was 2 pounds 11 ounces per month, while the average gain was 1½ pounds and the lowest 1 pound per month, the longest period on the diet being five and one-half months. There were four instances of craniotabes but this sign gradually disappeared under dietetic measures. No other manifestations of clinical rickets developed. There were eleven instances of nasopharyngitis, a few developing into otitis media, but as in the previous group, there was practically no change in the nutritional progress. One baby developed a severe bronchopneumonia but recovered, making a gain of 3 pounds in five months. The general progress and the number of calories fed differed very little from those in the first group.

Series 3. Infant Feeding.—In this series there were twenty cases with no fatalities. The average age was 4 months and the average weight 10½ pounds. The average gain in this series was 1¾ pounds per month, the best gain being 4 pounds and the lowest 2 pounds per month. The longest period on the diet was six months. Four cases presented definite craniotabes, in two of which it disappeared, while in the remaining two it not only persisted but definitely increased. The average caloric intake was 68 calories per pound. Seven patients in this series had infections, and in three cases there was a disposition to vomit which was not noted in the other groups. Only one patient did not do well. The general signs of improvement coincided with those of the two preceding groups.

Hospital Cases: Series 1. New-Born.—In this series there were eight cases. The average age of these infants was 7 weeks, the youngest being 2 weeks. The average weight was 4 pounds 12 ounces, the lowest being 3 pounds 1 ounce. The average caloric intake was at the rate of 82 calories a pound per day, the lowest being 60 calories and the highest 118 calories. They made an average gain of 10 ounces per month. The best gain was at the rate of 1 pound 3 ounces per month. The longest period which any of these infants were kept on this feeding

was two months. Two of these eight babies lost in weight while on the feeding, and four had respiratory infections to which one succumbed. The stools were uniformly good but tended rather to be more frequent in infants of this type than in the older, heavier babies.

Series 2. Atrophy (Marasmus).—This series comprises sixteen cases, with an average age of 3 months and an average weight of 8½ pounds. The lowest weight was 5 pounds 7 ounces. They were fed on the average of 70 calories per pound of body weight, the lowest rate being 50 calories per pound and the highest 84. The most rapid gain made was 2 pounds 6 ounces a month. The average rate of gain was 1 pound 4 ounces per month and the lowest rate of gain 1 ounce per month. One case lost weight. Ten infants in this series had a respiratory infection during the period that they were on the feeding, one case had rickets when the feeding was commenced and five more cases subsequently developed craniotabes while being fed on butter soup. It was noticed especially in this type of infant that they seemed much more contented and less irritable on this feeding than babies fed on plain milk and water mixtures or even preparations of lactic acid milk and corn syrup.

Series 3. Infant Feeding.—There were twenty-seven cases in this series. The average age was 4 months; the average weight 8½ pounds, the lowest being 5 pounds 11 ounces. These babies were admitted to the hospital on account of mild respiratory infections in most instances. In fact, only six out of the twenty-seven were free of infection during the time they were on the feeding. The average gain per month was 1 pound 1 ounce. The best gain was 2 pounds 4 ounces per month, the lowest 4 ounces. Only one infant lost weight. The average caloric intake per day was at the rate of 69 calories per pound, the lowest rate being 48 and the highest 84 calories. The longest period during which a baby was kept on this feeding in the hospital was three and one-half months.

In this group, out of the twenty-seven cases, five had rickets as evidenced by the presence of craniotabes and five developed craniotabes while on the feeding. A very noticeable feature has been the steady and consistent gain in weight made during the mild and even moderately severe infections. Patients with severe bronchopneumonia were kept on the butter soup feeding throughout the illness. It would appear that this feeding was tolerated much better than simple milk and water dilutions in such cases. The stools were uniformly good throughout. No child developed diarrhea necessitating a change in the feeding.

SYNOPSIS OF CLINICAL OBSERVATIONS

In all there were 104 cases for observation (fifty-one in hospital and fifty-three in private practice). Only five babies in the entire series

lost weight and did not do well. There were eight instances of mild rickets,[6] as shown by craniotabes. As is usual, those in private practice thrived better and on an average gained from ¾ to 1½ pounds more per month than the ward cases. The reasons for this are obvious.

Premature infants and those less than 3 months of age made the most substantial progress, while the reaction to parenteral infections was a most striking observation.

The caloric intake was extraordinarily high for all the series. The average was about 70 per pound, while many were given 80 and 85, and in one instance 118 calories per pound. The first sign of improvement usually noted was general comfort and reaction not unlike that of a normal breast fed baby; this was followed by improved sleep, increase in tissue turgor and color. It is worthy of note that vomiting was quite a subordinate symptom, and at no time was of a troublesome nature. In fact, it was frequently noted that infants who had previously been

TABLE 1.—RETENTION OF FAT, NITROGEN AND TOTAL SALTS

	Case 1			Case 2			Case 3			Case 4		
	Fat, Gm.	Total Nitrogen, Gm.	Total Salts, Gm.	Fat, Gm.	Total Nitrogen, Gm.	Total Salts, Gm.	Fat, Gm.	Total Nitrogen, Gm.	Total Salts, Gm.	Fat, Gm.	Total Nitrogen, Gm.	Total Salts, Gm.
Intake.....	29.86	2.213	2.752	27.01	2.001	2.489	27.01	2.001	2.489	21.24	1.575	1.959
Feces.....	5.49	0.341	1.491	7.53	0.445	1.506	7.18	0.452	1.592	3.96	0.318	1.389
Absorbed...	24.37	1.872	1.260	19.48	1.556	0.983	19.83	1.549	0.897	17.28	1.257	0.570
Urine.....	.....	1.697	0.308	.....	1.407	0.647	.....	2.296	0.942	.....	0.650	0.325
Retained....	24.37	0.175	0.952	19.48	0.149	0.336	19.83	—0.747	—0.045	17.28	0.607	0.245
Per Cent. of intake retained.....	81.6	7.9	34.6	72.1	7.5	13.5	73.4	.....	.....	81.4	38.5	12.5

vomiting on simple skim milk dilutions promptly ceased on the introduction of the butter-soup feeding. The longest period for which an infant was kept on this diet was 180 days.

With four of the children who were taking the butter-flour mixture, quantitative studies were made on the food intake and on the urine and feces. The average daily balance was obtained between intake and output of fat, nitrogen and total ash, and of some of the ash constituents. The intake, output in urine and feces and retention of fat, nitrogen and total ash are shown in Table 1. This study showed a very poor absorption of the fat of the butter-flour food, from 72.1 to 81.6 per cent. of the intake of fat, as compared with an average of about 95 per cent. for normal breast fed infants and about 90 per cent. for normal artificially fed infants. The nitrogen retention of three of the children under observation also was extremely poor, being less than 8 per cent. of the intake with two, and negative with another. The

6. The question as to whether or not this is true rickets is discussed by Dr. Tisdall, Am. J. Dis. Child. **24**:382 (Nov.) 1922.

fourth child had an unusually large nitrogen retention, more than 38 per cent. of intake. A retention of from twenty to twenty-five per cent. of the nitrogen intake is to be expected with young normal infants doing well on breast milk or modifications of cow's milk. The retention of the total salts varied greatly in these four children. One had a large retention, two fair, while one had a negative balance of salts. These very low retention values, especially those for fat and nitrogen, appear to be inconsistent with the clinical results obtained with this food.

As previously mentioned, Stolte [3] and Zielashowski,[4] working in connection with Stolte, made some metabolism observations with butter-flour feeding. In Table 2 are found Stolte's figures which have been changed so as to represent the daily values instead of the total for the three day period as given in his table. Stolte's results are fairly

TABLE 2.—RETENTION OF FAT, NITROGEN AND TOTAL SALTS
(STOLTE AND ZIELASKOWSKI)

	Case 1 (Stolte)			Case 2 (Stolte)			Case 3 (Stolte)		Case 4 (Zielaskowski)	
	Fat, Gm.	Total Nitrogen, Gm.	Total Salts, Gm.	Fat, Gm.	Total Nitrogen, Gm.	Total Salts, Gm.	Fat, Gm.	Total Nitrogen, Gm.	Fat, Gm.	Total Nitrogen, Gm.
Intake	24.21	1.22	2.81	10.51	0.878	1.450	23.03	1.114	23.20	1.398
Feces	7.34	0.78	0.996	3.07	0.238	0.829	3.92	0.305	2.02	0.218
Urine	.....	0.30	1.707	.....	0.284	0.809	.....	0.530	.....	0.714
Retained	16.87	0.14	0.107	7.44	0.356	—0.188	19.11	0.279	21.18	0.466
Per Cent. of intake retained	69.8	11.5	3.8	70.8	40.5	.....	82.9	25.1	91.3	33.3

comparable with those obtained in the present investigation. However, he found, on the whole, a rather higher nitrogen retention. Of his three cases, one had a small and two a large percentage retention of nitrogen. All three had a low percentage absorption of fat, two about 70 per cent. and one about 83 per cent. One had a low total salt retention and one a negative balance. The salt retention of the third was not determined. Zielaskowski found better fat absorption, only one of the four cases showing a percentage absorption abnormally low for artificially fed children. She reports only one determination of the nitrogen balance. In this case there was a high percentage retention.

Since butter-flour mixture somewhat resembles breast milk in composition and produces similar clinical results the question arises why the retention values are so different with the two foods. Some points of difference in the metabolism findings may be of more or less significance. Owing to the small volume of the food given, the absolute intake of fat with butter-flour mixture is not very great, usually from 20 to 30 gm. daily. This is less than the average intake of normal

breast fed infants.[7] On the other hand, the stools were much larger than those of normal breast fed babies. In the eight cases here studied the daily dried weight of the feces ranged from 8.4 to 14.2 gm., which is two or three times the average dried weight of the daily feces of normal breast fed infants. Stolte found in his three cases 13.72, 8.85 and 8.17 gm., respectively. Since the per cent. of fat in the stools of these infants averaged at least as high as that of the breast fed infants, about 48 per cent. and Stolte's 46 per cent. as compared with about 42 per cent. of the breast fed,[7] it can easily be seen how a much lower absorption of fat occurs with the butter-soup feeding.

It remains to be explained why the stools are so much larger with the butter-flour mixture. The difference in salt content, in starch content, and the difference in the nature of the fat and the protein, each or all may play a part in this connection. The nitrogen retention is less seriously affected by the large amount of the feces than the fat retention as the nitrogen excretion takes place largely through the urine. The urine, however, showed a large output of nitrogen except

TABLE 3.—COMPARISON OF BUTTER-FLOUR MIXTURE, BREAST MILK AND COW'S MILK—100 C.C.

	Fat, Gm.	Protein, Gm.	Total Salts, Gm.	CaO, Gm.	MgO. Gm.	P_2O_5, Gm.	Cl, Gm.	K_2O, Gm.	Na_2O, Gm.
Butter-flour mixture ⅔ plus ⅓ milk	5.04	1.83	0.443	0.081	0.015	0.120	0.114*	0.083	0.086*
Breast milk	3.3	1.15	0.206	0.047	0.008	0.034	0.035	0.057	0.014
Cow's milk	3.5-4	3.5	0.75	0.177	0.021	0.209	0.108	0.188	0.053

* Must vary according to salt in butter used.

in the case of the youngest and smallest infant. The salt intake with butter-flour mixture is so different from that with breast milk that there is no reason to expect the same conditions as to elimination and retention of salts with the two foods.

The differences in the amounts of the various salt constituents, between butter-flour mixture and breast milk and cow's milk, are shown in Table 3. The analyses of butter-flour mixture are those of the food as prepared at the Hospital for Sick Children. The other values are those reported by Holt.[8]

Table 4 gives the intake, output and retention of the various salts for the four children on whom the more complete studies were made. It is interesting to note the excellent calcium and magnesium retention

7. Holt, L. E.: Courtney, A. M., and Fales, H. L.: Am. J. Dis. Child **17**: 241 (March), 1919.

8. Holt, L. E.; Courtney, A. M., and Fales, H. L.: Am. J. Dis. Child **10**:229 (Sept.), 1915. Steinitz, F.: Jahrb. f. Kinderh. **57**:689, 1903. Freund, W.: Jahrb. f. Kinderh. **48**:137, 1898.

TABLE 4.—Retention of the Various Salts

	Case 1						Case 2						Case 3						Case 4			
	CaO, Gm.	MgO, Gm.	P_2O_5, Gm.	Cl, Gm.	K_2O, Gm.	Na_2O, Gm.	CaO, Gm.	MgO, Gm.	P_2O_5, Gm.	Cl, Gm.	K_2O, Gm.	Na_2O, Gm.	CaO, Gm.	MgO. Gm.	P_2O_5, Gm	Cl, Gm.	K_2O, Gm.	Na_2O, Gm.	CaO, Gm.	MgO, Gm.	P_2O_5, Gm.	Cl, Gm.
Intake	0.6974	0.0875	0.7972	0.6091	0.6672	0.4064	0.6307	0.0791	0.7210	0.5509	0.6034	0.3675	0.6307	0.0791	0.7210	0.5509	0.6034	0.3675	0.4965	0.0623	0.4992	0.4336
Feces	0.3459	0.0439	0.2776	0.0885	0.2210	0.1991	0.3706	0.0448	0.3568	0.1162	0.3849	0.2078	0.5781	0.0665	0.4300	0.0603	0.1743	0.1137	0.4030	0.0530	0.2295	0.1493
Absorbed	0.3515	0.0436	0.5196	0.5206	0.4462	0.2073	0.2601	0.0343	0.3642	0.4347	0.2185	0.1597	0.0526	0.0126	0.2910	0.4906	0.4291	0.2538	0.0935	0.0093	0.2697	0.2843
Urine	0.0131	0.0114	0.2459	0.2670	0.0960	0.0233	0.0316	0.0141	0.3600	0.3240	0.2133	0.1097	0.0424	0.0164	0.4462	0.3376	0.2369	0.1770	0.0049	0.0028	.....	0.2112
Retained	0.3384	0.0322	0.2737	0.2536	0.3482	0.1840	0.2285	0.0202	0.0042	0.1107	0.0052	0.0500	0.0102	−0.0038	−0.1552	0.1530	0.1922	0.0768	0.0886	0.0065	.....	0.0731
Per Cent. of intake retained	48.5	36.8	34.3	41.6	52.2	45.3	36.2	25.5	0.6	20.1	0.9	13.6	1.6	....	....	27.8	31.9	20.9	17.8	10.4	....	16.9

TABLE 5.—Composition of Feces

	Fat		Nitrogen		Total Ash		CaO		MgO		P_2O_5		Cl		K_2O		Na_2O	
	Gm.	Per Cent. of Dried Weight	Gm.	Per Cent. of Dried Weight	Gm.	Per Cent. of Dried Weight	Gm.	Per Cent. of Dried Weight	Gm.	Per Cent. of Dried Weight	Gm.	Per Cent. of Dried Weight	Gm.	Per Cent. of Dried Weight	Gm.	Per Cent. of Dried Weight	Gm.	Per Cent. of Dried Weight
Case 1	5.49	45.6	0.341	2.84	1.491	12.40	0.3459	2.88	0.0439	0.36	0.2776	2.31	0.0885	0.74	0.2210	1.84	0.1991	1.66
Case 2	7.53	57.6	0.445	3.40	1.506	11.52	0.3706	2.84	0.0448	0.34	0.3568	2.73	0.1162	0.89	0.3849	2.95	0.2078	1.59
Case 3	7.18	50.7	0.452	3.19	1.592	11.23	0.5781	4.08	0.0665	0.47	0.4300	3.03	0.0603	0.43	0.1743	1.23	0.1137	0.80
Case 4	3.96	39.6	0.318	3.18	1.389	13.89	0.4030	4.03	0.0530	0.53	0.2295	2.30	0.1493	1.49	.....	....	.....	....
Case 5	....	57.4	.....	1.83	.....	8.87	.....	2.52	.....	0.32	.....	2.82	.....	1.53	.....	....	.....	....
Case 6	4.67	50.1	0.353	3.78	1.034	11.08	0.3424	3.67	0.0528	0.57	0.4509	4.84	0.0626	0.67	.....	....	.....	....
Case 7	5.86	55.3	0.362	3.42	1.502	13.89	0.5374	5.07	0.0665	0.63	0.2304	2.17	0.0252	0.24	0.2247	2.12	0.053	0.50
Case 8	3.43	40.4	0.292	3.43	1.127	13.26	0.3791	4.46	0.0487	0.57	0.1561	1.84	.....	....	.....	....	.....	....
Case 9	3.73	44.6	0.245	2.93	0.990	11.84	0.3311	3.96	0.0394	0.47	0.1317	1.58	.....	....	.....	....	.....	....

for three of the children, since there has been some question as to the adequacy of the calcium intake with butter-flour mixture. The fourth child (B) had a negligible retention of calcium, with actually a negative balance of magnesium, phosphorous, and of total salts. This was the same child which had a negative nitrogen balance. He was much older than the other children, 9½ months, though undersized. He had the largest dried weight of feces of the eight children studied. It is possible that the intake of nitrogen and of salts was not adequate in this case. A good percentage retention of sodium and chlorin was shown consistently, although the actual amount retained was not excessive in any case. In all instances, there was a large excess of inorganic acids over bases in the urine, though the total salt content of the urine varied greatly. On the other hand, the feces showed the reverse condition, the quantity of bases far exceeding that of the acids. This would seem to indicate that there must have been a relatively large amount of organic acids in the feces holding the bases in combination, thus causing

TABLE 6.—Distribution of Fat in Feces

	Total Fat, Gm.	Fat, per Cent. of Dried Weight	Soap-Fat, per Cent. of Total Fat	Free Fatty Acids, per Cent. of Total Fat	Neutral Fat, per Cent. of Total Fat
Case 1	5.49	45.6	31.8	41.1	27.1
Case 2	7.53	57.6	44.9	33.4	21.7
Case 3	7.18	50.7	49.9	28.6	21.5
Case 4	3.95	39.6	45.1	40.4	14.5
Case 5	....	57.4	19.2	39.6	41.2
Case 6	4.67	50.1	52.6	30.0	17.4
Case 7	5.86	55.3	66.5	24.0	9.5
Case 8	3.43	40.4	54.8	30.3	14.9
Case 9	3.73	44.6	50.9	36.4	12.7

a low output of bases in the urine. The ammonia content of the urine presumably was high. Unfortunately, the twenty-four hour urines were mostly amphoteric or slightly alkaline, and ammonia was not determined. The distribution of acids and bases in urine and feces with butter-flour mixture is apparently in agreement with the claim of Steinitz that with fat-rich feeding there is little alkali, much ammonia in the urine, much alkali in the feces. That the loss of bases in the stools is relatively rather than absolutely great is, however, brought out in Table 5, which gives for these nine children a more detailed study of the composition of the feces. It is here seen that with all but two of the children the mineral content of the feces both as bases and acids was fairly uniform and not actually large in amount. It is necessary to study Table 6, which gives the distribution of the fat of the feces as soap, free fatty acids, and neutral fat, in order to see how far the presence of the higher fatty acids was responsible for the excess of bases in the feces. These values were obtained by determinations made

upon the dried feces. As the fresh stools with butter-flour feeding are distinctly acid, the soap values as obtained are necessarily higher than they would have been if determined on the fresh feces. It was observed by Holt et al.[7] that during the drying of acid feces, a portion of the fat present as free fatty acids becomes bound as soap. In the samples studied by them an average of about 10 per cent. of the total fat was found to be thus affected.

Applying this reduction to the soap values in Table 6, it is seen from the following computation that in Case 7, which had the highest percent of the total fat as soap, 66.5 per cent., only about 0.33 gm. calcium oxid could have been bound as soaps of the higher fatty acids, leaving 0.21 gm. of the calcium oxid of the feces to be otherwise held. Computation: Soap, per cent. of total fat as determined, 66.5; approximate soap, per cent. in fresh feces, 56.5; approximate amount of fat held as soap, 56.5 per cent. of 5.86 gm., or 3.3 gm.; approximate amount of calcium oxid held by 3.3 gm. stearic acid, 0.33 gm.; 0.54 gm. total amount of calcium oxid in feces, less 0.33 gm., combined with higher

TABLE 7.—WATER AND CHLORIN RETENTION

	Case 1		Case 2		Case 3		Case 4	
	Water, C.c.	Cl, Gm.	Water, C.c.	Cl, Gm.	Water, C.c.	Cl, Gm.	Water, C.c.	Cl, Gm.
Intake	774	0.609	700	0.551	700	0.551	551	0.434
Feces	93	0.089	78	0.116	53	0.060	83	0.149
Urine	200	0.267	270	0.324	277	0.338	175	0.211
Retention	481	0.253	352	0.111	370	0.153	293	0.074
Per Cent. of intake retained	62.1	41.6	50.3	20.1	52.9	27.8	53.2	16.9

fatty acids, leaves 0.21 gm. calcium oxid otherwise combined. Part of this was probably excreted as phosphate, but there is then the excess of potassium still to be accounted for. Thus the acids presumably arising from carbohydrate breakdown appear to be at least equally responsible with the higher fatty acids for the calcium withdrawal in the feces. By using the same method of computation with the values for the other cases it is found that all showed a large proportion of the bases of the feces that could not be excreted as salts of the inorganic acids nor as soaps of the higher fatty acids. In only two cases, that used above as an illustration and that of the older child who had a negative nitrogen and total ash balance, was the actual loss of bases large enough to endanger the retention. In these two cases there must have been inadequate calcium addition to the body.

The possibility that the great and rapid gain in weight might be attributable to edema is no more supported by the chemical than by the clinical findings. This is shown by Table 7, giving the water balance (exclusive of losses in perspiration and respiration) and that of chlorin

for the children whose total balances were obtained. Exclusive of the losses in perspiration and respiration, these four children retained from 50 to 62 per cent. of the fluid intake, or from 295 to 480 c.c. of water. Children fed on the butter-flour mixture, however, have a marked tendency to perspire freely, and these values undoubtedly must be very much reduced on that account. The chlorin retention was actually very small, though a fairly large per cent. of the intake. The chlorin content of the food, owing to the use of salted butter, is large in comparison with that of breast milk. It is not, however, much greater than that often taken in other forms of artificial feeding, in which usually a larger volume of food is taken.

Freund reports that from 0.012 to 0.159 gm. sodium chlorid, which equals from 0.007 to 0.095 gm. chlorid, are retained on breast feeding with an intake of from 0.254 to 0.329 gm. sodium chlorid, which equals from 0.152 to 0.197 gm. chlorin.

SUMMARY

1. The use of butter-flour mixture for very young and very small infants was generally attended by rapid and uniform weight gain, improvement in vigor, in tissue turgor, in disposition and in resistance to infection. Extraordinarily good results were obtained with many infants suffering from atrophy. It is not indicated, however, for children with diarrhea or other forms of severe fat or carbohydrate intolerance.

2. The caloric intake with this form of food was unusually high, averaging approximately 70 calories per pound.

3. In some cases signs of mild rickets, or a condition simulating mild rickets, were seen after continued use of butter-soup.

4. No edema was encountered.

5. If the weight became stationary after long continued use of butter-soup, the addition of protein to the food or temporary feeding with a cow's milk dilution was sufficient to bring about a continuation of the rapid weight gain.

6. The stools with this food were acid, strongly resembling those with breast milk feeding, but were much larger. Like breast milk feces they contained a high per cent. of fat.

7. There was generally a poor retention of fat and sometimes a poor retention of nitrogen and of total salts, especially by the older children.

8. There was usually a fair retention of calcium.

9. Sodium chlorid was not retained in abnormal amounts.

10. The feces contained an excess of inorganic bases over inorganic acids, and the urine showed the reverse condition. The excess of bases

in the feces was not to be accounted for by the quantity of fat excreted as soap, but apparently indicated the presence of lower acids.

11. Undoubtedly butter-flour mixture is a valuable addition to our resources in the feeding of premature, small and undernourished infants who are not suffering from any acute digestive disturbance.

The authors desire to express their gratitude to Dr. Stanley Graham, resident physician, for his analysis and synopsis of the clinical records of the hospital cases.

THE CALCIUM AND PHOSPHORUS CONCENTRATION IN THE SERUM OF INFANTS WITH MILD RICKETS OR A CONDITION SIMULATING MILD RICKETS

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Howland and Kramer [1] recently reported the results of an investigation of the calcium and inorganic phosphorus in the blood serum of infants with active rickets, and conclude that in the active stages of this disease the serum phosphorus is regularly reduced. The constant occurrence of some evidence of rickets in cases of tetany referred to by the older writers, and again recently emphasized by Brown and his co-workers [2] is now generally recognized. The calcium and phosphorus content of the serum of infants with active tetany have been determined by Kramer, Tisdall and Howland,[3] who found that the calcium was markedly reduced in all instances and in about half the cases the concentration of the inorganic phosphorus was normal or even above normal. As a result of these investigations it may be concluded that in active rickets the serum phosphorus is markedly reduced while in mild rickets associated with tetany the serum may have a normal or increased phosphate content.

Howland and Kramer [4] believe that when the product of the calcium concentration, multiplied by the phosphorus concentration expressed in mg. per 100 c.c. of serum reaches forty or more, rickets never results. When the product is less than thirty rickets always results, and when it is between thirty and forty the degree of rickets is slight or healing may occur. For instance, in an infant with active rickets in which the serum calcium is normal (10 mg. per 100 c.c.) and the phosphorus is reduced to 2.5 mg., the product equals twenty-five. Or, again, in an infant suffering from tetany with evidence of mild rickets the calcium may be reduced to about 6 mg. per 100 c.c. and the phosphorus remains normal (5.5 mg. per 100 c.c.). The product in this case is thirty-three. Another point of view is taken by Shipley, Park, McCollum and

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* From the Wards and Laboratories of the Hospital for Sick Children and the Department of Pediatrics, University of Toronto.

1. Howland, J., and Kramer, B.: Am. J. Dis. Child. **22**:105 (Aug.) 1921.
2. Brown, A.; MacLachlan, I. F., and Simpson, R.: Am. J. Dis. Child. **19**:413 (May) 1920.
3. Kramer, B.; Tisdall, F. F., and Howland, J.: Am. J. Dis. Child. **22**: 431 (Nov.) 1921.
4. Howland, J., and Kramer, B.: Tr. Am. Ped. Society, 1922.

Simmonds [5] who conclude that there are two main kinds of rickets—one characterized by a normal or nearly normal blood calcium and a low phosphorus (low phosphorus rickets), and the other by a normal or nearly normal blood phosphorus but a low blood calcium (low calcium rickets). These authors base their views on the experimental production of rickets in rats.

During the past year a general investigation has been made in the wards and laboratories of this hospital on the influence on infants of "butter-flour mixture" feeding. To facilitate this study, a number of patients who were gaining rapidly on this food were kept in the hospital for a considerable time. The inorganic phosphorus in the serum of many of these patients was determined, and it was generally found to be above the average level of normal infants. In some of the patients signs of mild rickets were present (craniotabes and slight enlargement of the costochondral junctions) and in these cases the serum calcium was found to be reduced from 10 to 30 per cent. below the average level of normal infants.

The inorganic constituents of the "butter-flour mixture" feeding have been determined in connection with a metabolism study reported by Brown, Courtney and MacLachlan.[6] These investigators found that one liter of the mixture contained 0.575 gm. calcium and 0.523 gm. phosphorus. This is a much higher proportion of phosphorus to calcium than is present in either breast milk or cow's milk and it was quite suggestive that the low calcium and high phosphate in the serum was the result of the concentration of these elements in the food. It was soon found, however, that many of the infants who were kept at home, but on the same feeding (obtained from the hospital), showed no signs of rickets. This indicates that there is some other factor than the food which is responsible for the production of the signs described. It was also found that infants on other feedings who had been in the hospital for a long time had signs of mild rickets and examination of their serum showed a diminished calcium with a normal phosphate content.

In Table 1 is given the calcium and phosphate content of the serum of infants who had signs of mild rickets. Some craniotabes and slight enlargement of the costochondral junctions were present in every case. In some of the patients who were under observation for two months or more the evidences of rickets became more marked during the period of observation. The average calcium concentration was 8.8 mg. and the

5. Shipley, P. G.; Park, E. A.; McCollum, E. V., and Simmonds, N.: Am. J. Dis. Child. **23**:91 (Jan.) 1922.

6. Brown, A.; Courtney, A. M., and MacLachlan, I. F.: Am. J. Dis. Child. **24**:368 (Nov.) 1922.

inorganic phosphorus content 6.1 mg. per 100 c.c. The average values found in normal infants by the methods used are 10.5 mg. calcium and 5.4 mg. phosphorus per 100 c.c. of serum.[7]

The calcium and phosphate content of the serum of infants who had signs of active tetany (carpopedal spasm, laryngismus, convulsions) in addition to rickets, are given in Table 2. The diets of the infants previous to the development of the tetany are also indicated. The

TABLE 1.—THE CONCENTRATION OF THE CALCIUM AND INORGANIC PHOSPHORUS IN THE SERUM OF INFANTS WITH EVIDENCES OF MILD RICKETS

Case No.	Serum No.	Age, Months	Date	Previous Diet	Length of Time on Previous Diet, Weeks	Calcium, Mg. per 100 C.c. Serum	Phosphorus, Mg. per 100 C.c. Serum
1	144	6	1/ 6/22	Butter-flour mixture	7	9.2	6.0
2	185	4	1/24/22	Butter-flour mixture	5	9.1	5.7
3	258	4	2/13/22	Butter-flour mixture	9	9.3	5.5
4	250	6	2/13/22	Butter-flour mixture	6	9.2	5.8
5	278	5	2/17/22	Butter-flour mixture	7	9.2	6.9
6	202	6	1/26/22	Butter-flour mixture	10	8.8	6.5
7	188	4	1/24/22	Butter-flour mixture	7	7.9	7.5
7	257	4¾	2/13/22	Butter-flour mixture	10	7.0	7.0
8	481	3	4/19/22	Butter flour mixture	11	8.8	6.1
9	484	..	4/21/22	Whole milk dilutions	30	9.1	4.7
10	432	18	4/ 6/22	Milk, bread, potatoes	24	9.2	6.8
11	387	4	3/23/22	Whole milk dilutions (Protein milk for 1 week)	10	9.3	5.4
	Average					8.8	6.1

TABLE 2.—CONCENTRATION OF THE CALCIUM AND INORGANIC PHOSPHORUS IN THE SERUM OF RACHITIC INFANTS WITH TETANY IN ADDITION

Case No.	Serum No.	Age, Months	Date	Previous Diet	Length of Time on Previous Diet, Weeks	Calcium, Mg. per 100 C.c. Serum	Phosphorus, Mg. per 100 C.c. Serum
1	81	6	11/30/21	Eagle Brand condensed milk	21	5.4	6.7
2	186	2½	1/24/22	Breast milk and butter-flour mixture	8	7.9	6.4
3	362	5	3/10/22	(1) Whole milk dilutions followed by (2) Eagle Brand condensed milk	(1) 6 (2) 4	5.9	5.3
4	385	12	3/20/22	Breast milk	..	5.2	6.8
5	390	8	3/23/22	Whole milk dilutions	20	5.8	7.1
6	408	5	3/27/22	Eagle Brand condensed milk	8	7.5	5.6
7	400	9	3/27/22	Whole milk dilutions	20	5.4	5.8
8	430	11	4/ 6/22	Whole milk dilutions	40	5.0	5.8
9	431	7	4/ 6/22	Whole milk dilutions	..	6.7	3.4
	Average					6.1	5.9

average calcium content found in the serum of these nine cases was 6.1 mg. calcium per 100 c.c., which compares with 5.4 mg. reported by Kramer, Tisdall and Howland [3] and 5.6 mg. by Howland and Marriott.[8] The average phosphate content found was 5.9 mg. per 100 c.c. of serum.

7. Kramer, B., and Tisdall, F. F.: J. Biol. Chem. **47**:475, 1921. Tisdall, F. F.: J. Biol. Chem. **50**:329, 1922.

8. Howland, J., and Marriott, W. McK.: Quart. J. M. **11**:289, 1918.

None of the cases reported here had what would be termed severe rickets. In some of the infants with active tetany there was a moderate enlargement of the epiphyses, while in the other cases no enlargement could be detected by clinical examination. Roentgenograms of the wrists disclosed, in the more marked cases, moderate flaring and some irregularity of the lower ends of the radius and ulna. In the other patients only the barely perceptible "fuzziness" which is generally seen in cases of tetany could be detected.

In a recent communication [9] some statements made by Hess are of considerable interest in the light of the present study. He states: "Routine blood examinations were carried out on infants who were receiving standard diets, in order to ascertain the relationship of blood phosphate to the early development of rickets . . . in general it was found that clinical rickets may precede a decrease in the inorganic phosphate of the blood but that the later roentgen-ray signs were accompanied usually by a low blood phosphate." However, no calcium determinations were reported. It is quite possible that the mild cases that Hess observed were cases of rickets of the type associated with a normal phosphate concentration in the blood serum and a diminished calcium concentration.

In the same communication Hess states that the blood of infants apparently free from rickets, according to all recognized signs and symptoms, may be low in inorganic phosphate. After making several hundred determinations of the inorganic phosphate content of serum of normal infants, and others suffering from various pathologic conditions, I am convinced that a diminished inorganic phosphate content of the serum does not occur in normal infants or at least is extremely rare. It is possible that the difference between the results recorded by Hess and the above results is due to the different methods used, or to the fact that his determinations were made on whole blood, while the present ones were made on blood serum. As the inorganic phosphate content of corpuscles and serum are not identical, and as it is the serum and not the corpuscles which tends to be in equilibrium with the tissue fluids, it is probable that the phosphate content of the serum is of more value than that of whole blood.

The question may be raised whether the patients without tetany were really suffering from rickets in the true sense of the word. The product of the average calcium and phosphorus concentration in the serum of these infants is fifty-three. According to Howland and Kramer's view, there should have been no evidence of rickets, as the product of the concentration of the calcium and the phosphorus is well above forty. In these infants the clinical evidence of rickets consisted only of craniotabes and slight enlargement of the costochondral junc-

9. Hess, A. F.: J. A. M. A. **78**:1177 (April 22) 1922.

tions. Schwarz,[10] Unruh,[11] Feer[12] and others considered these signs diagnostic of rickets and concluded that this disease occurred in from 50 to 80 per cent. of newly born infants. Schmorl,[13] who is probably one of the greatest authorities on rickets, conducted an extensive investigation of the disease and found no microscopic evidence of rickets in the bones until the second month of life. Thus it is clear that these signs alone cannot be taken as evidences of true rickets. Park, Shipley, McCollum and Simmonds[14] have found that diets very high in phosphorus and very low in calcium produce changes in the bones of rats which differ from rickets. "The bones were thin. The enlargement of the costochondral junctions and ends of the long bones were slight or lacking. Fractures were not found." In view of these facts, the possibility must be considered that the bone change which accounted for the craniotabes in our patients, without definite involvement of the long bones, might be more of an osteoporotic nature than true rickets.

CONCLUSIONS

1. The calcium and inorganic phosphorus concentration in the serum of a number of infants with craniotabes and slight enlargement of the costochondral junctions averaged 8.8 mg. calcium and 6.1 mg. phosphorus per 100 c.c. of serum. The average values found in normal infants by the methods used are 10.5 mg. calcium and 5.4 mg. phosphorus per 100 c.c. of serum.

2. The average concentration of the calcium and inorganic phosphorus in the serum of a number of infants with signs of active tetany in addition was 6.1 mg. calcium and 5.9 mg. phosphorus per 100 c.c. of serum.

3. The question is raised whether the bone changes observed (craniotabes and enlargement of the costochondral junctions) were not more of an osteoporotic nature than true rickets.

I wish to acknowledge thanks to Dr. Alan Brown, physician-in-chief, for permission to report these cases.

10. Schwarz, F.: Med. Jahrb. **2**:495, 1887.
11. Unruh: Jahresb. d. Gesellsch. f. Nat. u. Heilk. in Dresd. **53**:1886.
12. Feer, E.: Festschrift, Ed. Hagenbach-Buckhardt, Leipzig, 1897, p. 67.
13. Schmorl, G.: Ergebn. d. inn. Med. u. Kinderh. **4**:403, 1909.
14. Park, E. A.; Shipley, P. G.; McCollum, E. V., and Simmonds, N.: J. Biol. Chem. **50**: VII, 1922.

THE INCIDENCE OF MENINGITIS IN EARLY INFANCY, WITH A DESCRIPTION OF TWO CASES DUE TO UNUSUAL ORGANISMS*

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Although meningitis is common in childhood, it is rather infrequent in early infancy and relatively few instances have been described in infants under 3 months of age. This may be due, in part, to the relative isolation of young infants and the consequent lack of opportunity for infection. A variety of micro-organisms has been associated with meningeal infections, and it is of interest that certain of them have been particularly associated with meningitis in early infancy while infection with other types of organisms has been relatively rare. It is also noteworthy that certain types of bacteria which not infrequently cause meningitis in early infancy are rarely associated with such infections later in life. In this paper are reported two instances of meningitis in young infants caused by organisms of this latter type. In addition we have observed four cases of meningococcus meningitis (cerebrospinal fever), two others due to the streptococcus and two to the pneumococcus. All were in children under 3 months of age. Before describing the cases we have observed, we will review briefly the incidence of meningitis in infants under 3 months of age.

Meningococcus.—While it seems likely that all instances of meningococcus meningitis in early infancy have not been reported, we have been able to find only twelve cases[1] in the literature of the past five years. Even assuming the existence of an equal number of similar unreported cases, the rarity of infection in early life as compared with the incidence later is apparent. In thirty-five consecutive cases of meningococcus meningitis admitted to the St. Louis Children's Hospital in children under 2 years, four were under 3 months of age. This is a relatively high proportion and, we believe, the occurrence of the infection in early infancy is, in general, much more infrequent than

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1. Koplik, H.: (4 cases), Arch. Pediat. **33**:481 (July) 1916; White, T. W.: (1 case), Arch. Pediat. **34**:372 (May) 1917; Acuña, M., and Casaubon, A.: (3 cases), Arch. de méd. d. enf. **21**:169 (April) 1918; Ugon, A.: (1 case), Arch. Lat. Am. de Pediat. (Nov. and Dec.) 1918; abstr. in Arch. de méd. d. enf. **22**:557 (Oct.) 1919; Castro, R.: (1 case), Arch. Lat. Am. de Pediat. (March and April) 1920; abstr. in Arch. de méd. d. enf. **23**:555 (Sept.) 1920; Gutierrez, A. C.: (1 case), Arch. Españoles de Pediat. **4**:385 (July) 1920; Rémy, A., and Caussade, L.: (1 case), Paris méd. **11**:129 (Feb. 12) 1921.

indicated by these figures. It seems more reasonable to attribute the low incidence in very young infants to their isolation rather than any immunity to this infection.

The first case, the youngest observed, was a fulminating infection in an infant, 17 days old, accompanied by an extensive petechial rash. The organism isolated was identified as a parameningococcus by agglutination tests. This variety of the meningococcus appears to be the more common one in St. Louis since of seven strains isolated and identified from this and other cases of cerebrospinal fever, only one was the regular or normal meningococcus, the rest being parameningococcus. The second case was in an infant, 10 weeks of age, seen rather late in the disease which was uninfluenced by serum treatment. The other two cases were in infants, 2 months old, who recovered, although one developed a hydrocephalus. It is of interest that these four cases furnish examples of all the usual clinical forms of cerebrospinal fever in infancy: (1) the fulminant, rapidly fatal type, with extensive petechial rash; (2) the rather severe form which is not treated until the second week and which is little affected by specific therapy; (3) the infant also treated somewhat late who recovers with a chronic basilar meningitis and hydrocephalus, and (4) apparently complete recovery under serum treatment with no hydrocephalus or other apparent residue of the infection.

Bacillus tuberculosis.—Tuberculous meningitis, frequently an incident in a general miliary tuberculosis, is also relatively rare in early infancy. Holt,[2] in a series of 218 cases of tuberculous meningitis in children under 3 years of age, found only three cases in infants less than 3 months old. The low incidence in early infancy is due, in part, to the lessened opportunity for infection that the relative isolation of this age gives. There is probably another factor which contributes to the small number of cases observed. Tuberculous meningitis is always secondary to some focus of tuberculosis elsewhere in the body. Although the marked susceptibility of infants to tuberculosis and the relative rapidity with which the infection may spread are recognized, nevertheless, a certain period of time is required after infection for the development of the initial lesion, and for the metastasis to the meninges to occur. It is not surprising that in only occasional instances the development of the infection is sufficiently rapid for meningitis to result in early infancy. We have seen no case under 3 months of age.

Bacillus influenzae.—In a series of forty-nine cases of meningitis caused by the Pfeiffer bacillus collected by Wollstein,[3] three of the

2. Holt, L. E.: Observations on Three Hundred Cases of Acute Meningitis in Infants and Young Children, Am. J. Dis. Child. **1**:26 (Jan.) 1911.

3. Wollstein, M.: Influenzal Meningitis and Its Experimental Production, Am. J. Dis. Child. **1**:42 (Jan.) 1911.

patients were noted as being under 3 months of age, although four infants whose age was not given were designated "nurslings," and may have been very young infants.

Recently Neal [4] reported thirty-two cases of which two were in infants under 3 months old, and of twenty-three cases reported by Rivers,[5] one child was under 3 months. About half of all reported cases occurred during the first year of life. The only case we have observed was in a 5 months old infant in which the meningeal infection was apparently primary. The organism isolated was typical.

Streptococcus, Staphylococcus, and Pneumococcus.—Purulent meningitis from these common pyogenic cocci is apparently somewhat more frequently observed in early infancy than the form due to the other organisms mentioned. Barron [6] has collected from the literature fourteen cases, six due to the streptococcus and staphylococcus, four to the streptococcus alone and four to the pneumococcus. Four of these infants had spina bifida. It is likely that a considerable percentage of the others may have been associated with the extension of an infection from the middle ear and mastoid, or with pneumonia since this is true in older infants.

Of thirty cases of purulent meningitis from pyogenic cocci observed in the St. Louis Children's Hospital, half the patients were under 2 years of age and four were under 3 months old. In two of these young infants the meningitis was caused by a streptococcus and in two by a pneumococcus. The streptococcus infection in one infant (22 days old) was associated with a spina bifida and in the other (2 months old) with a brain abscess. One of the cases of pneumococcus meningitis was of the group usually called "primary" and was immediately preceded by an acute follicular tonsillitis and rhinopharyngitis, while the other accompanied an empyema. Both infants were 2 months of age. The association of purulent meningitis with middle ear and mastoid infection, due to these pyogenic cocci, is not uncommonly noted in childhood but we have not observed a case of this type in early infancy.

Colon Bacilli and Allied Intestinal Bacteria.—It is this group of organisms that is of particular interest with relation to meningitis since such infection is apparently peculiar to very young infants. Eighteen cases were collected by Barron [6] of which fifteen were in infants under 3 months of age and of the other three one child was 4 months old and two were 5 months old. The organisms isolated were *B. coli* in fourteen cases; *B. lactis aerogenes, B. mucosus capsulatus, B. pyocyaneus* and

4. Neal, J. B.: Influenzal Meningitis, Arch. Pediat. **38**:1 (Jan.) 1921.

5. Rivers, T. M.: Influenzal Meningitis, Am. J. Dis. Child. **24**:102 (Aug.) 1922.

6. Barron, M.: Meningitis in the Newborn and in Early Infancy, Am. J. M. Sc. **156**:358 (Sept.) 1918.

B. typhosus, each in one instance. Since this report Greenthal [7] has observed a case of meningitis in an infant one month old which was due to *B. acidi lactici.* Smith and Aberd [8] have isolated *B. enteritidis* (Gaertner) from the meningeal exudate of a 5 weeks old infant, and Sherman [9] has reported a newly-born infant with *B. acidi lactici* meningitis. It is rather striking that meningeal infection by organisms of this group is so sharply limited to early infancy since apparently similar cases are seen rarely, if at all, in late infancy and childhood.

We have observed two instances of infection in young infants with organisms of this type. The first case was in an infant 10 weeks old with meningitis due to a colon-like bacillus which was agglutinated by the patient's serum. Intraventricular injections of the patient's serum were without apparent influence on the course of the infection. The second case was in an infant 4 weeks old with hereditary syphilis who developed a purulent meningitis caused by an encapsulated bacillus not corresponding to any previously described micro-organism.

REPORT OF CASES

CASE 1.—*History.*—N. W., a white male infant, 10 weeks of age, was admitted to the St. Louis Children's Hospital, June 16, 1921, with the complaints of malnutrition, irritability and constipation. The parents were in good health and had no other children. The baby had been delivered by a midwife and was said to have weighed 9 pounds at birth which was spontaneous and at term. It had never been nursed but had been fed at two hour intervals on a dried milk preparation. Frequent enemas had been given on account of a persistent constipation. Vomiting had followed many of the feedings and had been present since birth.

Examination.—On admission, the examination showed a moderately atrophic infant weighing 3,200 gm. with a temperature of 37 C., not acutely ill. The head appeared to be somewhat large; there was some fulness of the anterior fontanel, and the sutures were slightly separated. In addition, the neck was moderately retracted and stiff. On bending the neck forward there was a slight flexion of the thighs, but Kernig's sign was absent. Aside from some increased irritability on being handled, the physical examination was otherwise negative. The leukocytes numbered 28,800. On lumbar puncture 15 c.c. of a greenish yellow turbid fluid was removed which showed 15,000 cells per c.c. with 87 per cent. polymorphonuclears. Gram-negative rods in fair numbers were present in smears and grew in pure culture from this as well as all successive puncture fluids. Their cultural characteristics will be discussed later.

Course.—During the following six days, the patient's condition remained practically unchanged, although frequently there was moderate vomiting after feeding, and gradual loss of weight. The fontanel became more tense but from a second lumbar puncture no fluid was obtained. Since it had been found that the organism isolated from the first puncture fluid was agglutinated by the patient's serum in dilutions of 1:80, 10 c.c. of the patient's serum was

7. Greenthal, R. M.: Case of Meningitis Due to the Bacillus Acidi Lactici, Am. J. Dis. Child. **21**:203 (Feb.) 1921.

8. Smith, J., and Aberd, M. D.: Gaertner Meningitis Complicating Gaertner Enteritis, Lancet **2**:705 (Oct. 1) 1921.

9. Sherman, De W. H.: A Peculiar Case of Purulent Meningitis in the Newborn, Tr. Am. Pediat. Soc. **34**:192, 1922.

injected into the ventricle. No effect from this injection was observed. Two days later the infant had a convulsion which lasted less than a minute, and another ventricular puncture was done with the introduction of 10 c.c. more of the patient's own serum. This was followed by slight improvement, but the child had several more convulsions and died the next day—nine days after admission. During observation in the hospital the temperature varied between 36 and 38 C. The urine was negative. The Pirquet and the Wassermann reactions were negative.

Diagnosis.—Purulent meningitis due to a paracolon bacillus; internal hydrocephalus (secondary) and athrepsia.

Necropsy Report.—A complete necropsy was performed which confirmed the foregoing diagnoses. The body was much emaciated and weighed 2,800 gm. A rather thick fibrinopurulent exudate covered the brain. The ventricles were moderately dilated and contained pus. Sections showed the exudate to be composed of much fibrin, many polymorphonuclear and both large and small mononuclear leukocytes. There was a well marked perivascular infiltration also. Through the lungs were scattered small areas of a dark red color which, on microscopic examination proved to be patches of atelectasis and early pneumonia. The intestines were free from anatomical abnormalities. Other details of the necropsy protocol will be omitted since nothing of special interest was revealed.

Anatomic Diagnosis: fibrinopurulent meningitis and ependymitis; internal hydrocephalus; lobular atelectasis; commencing bronchopneumonia; emaciation.

Bacteriology.—The cerebrospinal fluid removed from the spinal puncture and from the two ventricular punctures during life and that found in the ventricles at necropsy was purulent, of a greenish yellow color and had a faint odor of putrefaction. Microscopic examination showed many pus cells and gram-negative rods resembling colon bacilli. They were extracellular. Cultures from the puncture fluids and those made postmortem showed an abundant pure growth of the same organism.

Serum from the patient taken five days before death gave complete agglutination of the organism in dilutions of 1:20, 1:40 and 1:80, but did not agglutinate *B. typhosus, B. paratyphosus A, B. coli-communior* in dilutions of 1:20. The organism isolated from the patient was not agglutinated by pooled normal human serum.

The organism was motile, methyl red test positive, and Voges-Proskauer test negative. Indol was produced. Gelatin was not liquefied. Milk became slightly acid and was coagulated on the second or third day. Acid and gas were formed from dextrose, saccharose, mannite, xylose, maltose, arabinose, glycerol, galactose, adonite, levulose and sorbitol. Acid and gas production from salicin and rhamnose was delayed. Acid production from lactose was delayed and no gas was produced. Raffinose, dextrin, inulin, starch, dulcitol, amygdalin, inositol, and erythritol were unaffected.

The medium used was 1 per cent. peptone, 0.4 per cent. dibasic sodium phosphate, and Bronfenbrenner's indicator, with Durham fermentation tubes. Hiss' serum water was also used. Sugars were used in 1 per cent. strength. The media with most sugars was filtered through a diatomaceous filter and was not heated. Cultures were incubated ten days.

Cultures from the heart's blood were sterile.

Case 2.—*History.*—Baby A., colored, female, was first seen Sept. 26, 1921, at the age of 10 days when brought to the Washington University Dispensary with the complaint of a rash on the hands and feet which had appeared four days previously. The mother had had two miscarriages and her blood, taken two weeks before the birth of the patient, showed a strongly positive Wassermann reaction. It was stated that the birth-weight was 5 pounds and that the infant had been fed at the breast every two hours and appeared to be well with the exception of the skin trouble.

Examination.—On examination, the patient was a poorly nourished infant with enlarged epitrochlears and a large liver and spleen. Both feet and both hands were covered by large bullous lesions.

Course.—Daily inunctions of mercury were prescribed and breast feedings at three hour intervals. During the following two weeks the baby was seen several times and the skin lesions were regressing, although the nutrition remained unsatisfactory. Oct. 13, 1921, when 4 weeks old, the infant was brought to the clinic with the history that convulsions had begun the previous day and recurred at intervals since. The temperature was 35.8 C., and the baby was having rather frequent general convulsions. The sclerae were considerably jaundiced, a symptom which had not been noted previously. Lumbar puncture showed a yellow turbid fluid under increased pressure containing 1,500 cells, most of which were polymorphonuclears. The supernatant fluid after centrifugation was golden yellow and gave a strong test for bile. The Wassermann reaction was strongly positive on 0.4 c.c. In stained smears from the sediment rather numerous gram-negative rods were seen within the cells. The convulsions continued and the baby died several hours later. No necropsy was obtained.

Diagnosis.—Hereditary syphilis; acute purulent meningitis; jaundice.

BACTERIOLOGY.—A gram-negative bacillus with morphology similar to *B. coli* was present in stained films from the purulent cerebrospinal fluid and was recovered in pure culture. Many of the bacilli were intracellular.

The organism has been studied thoroughly by one of us (H. H. B.), but only a summary of the more important characteristics will be given. In morphology it closely resembles *B. coli* and shows similar variations in size, although most of the individuals are fairly uniform. It is readily stained by all the usual dyes, and is decolorized by Gram's method. Spores are not produced. The growth is aerobic and facultative anaerobic, and abundant on all media. Gelatin and Loeffler's blood serum are rapidly liquefied, and litmus milk is quickly peptonized with little change in reaction. Growth occurs at room temperature almost as well as at 37 C. The organism is nonmotile.

On all solid mediums the growth is very tenacious and elastic. It is drawn out by the needle and when broken snaps back like an elastic band. In broth, a mucoid, flocculent sediment forms with diffuse clouding of the medium. This stringy substance is precipitated by dilute acid and is probably mucin, although its further identification was not attempted.

Indol is produced in very small amount as shown by the vanillin test, but the cholera red and paradimethylamidobenzol tests are negative.

No fermentation with gas production occurs in any of the sugars mentioned in the description of the organism from Case 1. With some of these sugars small amounts of acid were produced which changed the p_H from 7.5 to from 7.0 to 6.6, but the acidity never went below this latter point. Quantitative tests showed a disappearance of a very small amount of the sugar after ten days' incubation. Such reactions, however, are not at all comparable to the usual carbohydrate fermentation by members of the colon group.

Rabbit and guinea-pig inoculations were without effect, but intraperitoneal inoculation with a mouse caused death in twelve hours. The peritoneal exudate was mucoid with numerous organisms which showed a small capsule by Hiss' method.

The organism described is distinguished from the encapsulated colon-aerogenes group, mucosus capsulatus and hemorrhagic septicemia group by being very proteolytic and by other characteristics. The most conspicuous peculiarities, in addition to its great proteolytic action, are its inability to attack sugars energetically with marked acid production and the elastic character of its growth. In view of the

latter peculiarity we propose the name *Bacterium elasticum* to distinguish it from the other species of encapsulated organisms already described.

DISCUSSION

The occurrence of meningitis in early infancy apparently depends on several factors. The four cases of meningitis due to the meningococcus present no essential differences from instances observed later in childhood and it seems likely that the low incidence in the early months of life is due almost entirely to the relative isolation of the very young. Purulent meningitis caused by such pyogenic organisms as streptococci and pneumococci, as illustrated by the instances we have observed and others in the literature, also differs little in its pathogenesis, whether occurring in early infancy or later with one exception. Infants with spina bifida in which the covering of the sac is thin, may be infected as a result of trauma to the tumor and the direct extension of an infection of the skin. In this condition the dura is cleft, as well as the vertebral laminae, and does not cover the sac, the arachnoid being immediately beneath the skin. Otherwise, such purulent meningitis both in early infancy and later is secondary to other pyogenic inflammations either by direct extension, or from otitis media, or brain abscess, or transmission by the blood from a pneumonia or other more or less distant suppuration. Any decrease in the incidence of such purulent meningitis in early infancy may be attributed merely to the fact that severe suppurative and inflammatory lesions are more common later than in the earliest months of life. In contrast to the types of organisms already mentioned, however, are those cases of meningitis in young infants caused by the group of colon bacilli and other gram-negative bacilli of the intestinal tract. These infections form a distinct group peculiar to the newly-born and infants in the early months of life and do not occur in older children. We have observed two cases of this variety. The clinical symptoms of the different varieties of meningitis seen in early infancy have shown nothing especially characteristic or strikingly different from similar infections in later infancy and childhood.

The cases of meningitis due to intestinal bacteria have especially interested us from the standpoint of the organisms involved and the origin of the infection. Most of the organisms mentioned in connection with these cases and designated *B. coli* have not been described in sufficient detail to determine definitely their identity. It may be possible that certain members of the colon group are particularly associated with meningitis in infancy but this can only be determined by a comparison of detailed descriptions of the cultures isolated. Because of the multiplicity of types and the differences in classification of this group, considerable detail in description of strains isolated from such cases

would be of value. On the other hand, it is evident, even from the relatively meager reports, that the meningeal infection may be caused by any one of several more or less distinct varieties of bacteria found commonly in the intestinal tract and not ordinarily considered capable of a virulent invasion of the body. In the instances we have observed, the organism isolated from the first case obviously belongs to the large number of bacteria intermediate between the typhoid and colon groups, but differs in minor details from other species previously described. The organism in the second case is strikingly peculiar and belongs to a capsulated group of bacteria. It differs, however, from the mucosus capsulatus group and from the hemorrhagic septicemia group by being very proteolytic and in other respects. It is apparently a distinctly new type of organism and we propose to designate it *Bacterium elasticum* from the elastic character of the growth in culture.

The origin of the meningeal infection in these cases is somewhat obscure since, in practically all the instances observed, no other focus of infection has been present. These cases are termed, therefore, "primary" meningitis. On account of the type of bacteria involved it is, perhaps, a natural assumption that the organisms were derived from the intestinal tract and reached the meninges through the blood. Direct evidence in proof of such an explanation is difficult to obtain, but it is of interest to see how certain known phenomena give indirect evidence to support this hypothesis. Three factors are apparently involved in the production of purulent meningitis by intestinal bacteria. These are: (1) the greater permeability of the intestinal mucosa in early infancy; (2) the decreased resistance of young infants to bacterial infection associated with defective antibody formation, and (3) the influence of digestive disturbances and malnutrition on the above mentioned factors.

The permeability of the adult intestinal mucosa for bacteria of the colon group is well known from the ease with which they may be demonstrated in the mesenteric lymph nodes and even in the liver. These organisms, however, appear to be destroyed by the body without the production of any evidence of infection. The fact that the serum of most persons contains agglutinins for colon bacilli—the so-called "normal" agglutinins—is usually attributed to this more or less constant passage of these bacteria into the body, while the infrequency of infections is ascribed to the presence of acquired immune substances of which the "normal" agglutinin is an example. It has been shown by von Behring [10] that the intestinal mucosa of young animals is more permeable to bacteria and to foreign proteins than that of older animals.

10. Von Behring, E.: Einführung in die Lehre von der Bekämpfung der Infektionskrankheiten, Berlin, Hirschwald, 1912, p. 371.

Similarly, Lawatschek [11] has demonstrated that in young infants foreign protein may pass through the mucosa of the intestine unchanged and may be recognized in the urine by the precipitin test. It seems, therefore, a justifiable assumption that in early infancy the permeability of the intestinal mucosa for colon bacilli and allied organisms is increased.

There are a number of observations regarding the lack of production of antibodies by young animals and by infants. One instance is the absence of complement-fixing substances in tuberculosis of infants in the first year of life [12] although such substances appear in a considerable proportion of older children with the infection. Isohemagglutinins, also, are usually absent in the serum of the newly-born infant. Although it has been shown experimentally that newly-born animals may inherit recognizable amounts of certain immune substances, such as hemolysins and agglutinins by their transmission through the placenta, this occurs only when the mother's serum contains a fairly high concentration of these antibodies. The concentration of normal agglutinins for the colon group, however, is relatively low, and the serum of new-born animals contains none of these normal agglutinins. Since these substances can readily be demonstrated later in life, they are assumed to be an evidence of an immunity acquired by the absorption of bacteria from the intestinal tract. Their absence in the early months of life, therefore, may be associated with a lowered power of resistance to infection by members of this group.

The relation of malnutrition and digestive disturbances in infants to infection is little understood but it is generally recognized that infants who are poorly nourished are definitely more susceptible to infections. The greater the degree of athrepsia, the lower the resistance appears to be. In both cases observed by us the nutrition was poor, one infant being moderately athreptic, from improper feeding, and the other suffering from hereditary syphilis, a disease which is not infrequently associated with malnutrition and greater susceptibility to other acute infections. It seems likely that the poor nutrition in these cases may have been one of the factors that was concerned in the production of these meningeal infections.

SUMMARY

The incidence of acute meningitis in infants under 3 months of age is briefly reviewed with mention of four cases due to meningococcus, two to streptococcus and two caused by pneumococcus observed in early infancy. Two cases are described in which the organisms involved

11. Lawatschek, R.: Die enterale Resorption von genuinem Eiweiss bei Neugebornenen und darmkranken Säuglingen und ihre Ververtbarkeit als Funktionsprüfungsmethode, Prag. med. Wchnschr. **39**:185 (April 16) 1914.

12. Cooke, J. V.: Complement Fixation for Tuberculosis in Children, Am. J. Dis. Child. **21**:78 (Jan.) 1921.

were gram-negative bacilli of the type commonly found in the intestinal tract. One of these belonged to the group of paracolon bacilli, but did not correspond exactly in fermentation reaction to other described strains, while in the second case the organism isolated was an encapsulated proteolytic nonfermenting bacillus apparently not hitherto observed. On account of the tough elastic growth on culture mediums, we have suggested the name *Bacterium elasticum* for this organism.

The fact that meningeal infection with colon bacilli and allied organisms is usually unaccompanied by recognizable infection elsewhere in the body suggests that these bacteria gain entrance through the intestine. The possible relation of various factors in explaining why such infections are confined to early infancy is discussed, and reasons given for the belief that the increased permeability of the intestinal mucosa to bacteria, the absence of inherited immunity to the colon group, the imperfect power of antibody formation in young infants, and the general lowered resistance accompanying malnutrition predispose to infection by organisms of this type.

A STUDY OF THE SHADOWS IN THE THORAX OF THE NEWLY-BORN*

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NEW ORLEANS

This study was undertaken with the hope of devising some method by which the abnormal shadows in the thorax of the newly-born could be differentiated from the normal ones. At the onset we appreciated that we had undertaken a problem of greater magnitude than we had expected. The deeper we went into the subject the greater was the variance in the shadows that we found could exist without causing any clinical symptoms. It was soon fully appreciated by us that it would require the study of a large series of cases before any attempt could be made to declare the normal to be such, and further we became more forcibly convinced that the normal shadows would first have to be determined before the abnormal could be recognized.

In presenting the observations of the study we do so in the form of a preliminary report.

Our study is based on observations made in a series of fifty-two newly borns. It included careful physical examinations and accurate measurements of all the cases examined, which cases were consecutive in the Newly-Born Service at the Touro Infirmary, and were not selected. Every baby was roentgenographed within the first forty-eight hours after birth with one exception, a premature, whose observations were made when he had reached 3 pounds, 14½ ounces. In none of the cases in this series was there a heart murmur, and in none was there any clinical evidence of an enlarged thymus. In no instance was there the slightest indication of inconvenience to the patient nor of interference in his normal progress following the making of the roentgenogram. We have not been able to find in the literature any studies made on the small child such as we were to make, and hence had nothing to start from. The methods devised by the workers in the adult investigations of the heart we found could not be employed in our study. In the adult the heart shadow is fixed and the normal may readily be recognized and any deviation therefrom determined. In the infant, and especially in the newly-born, the influence of development and growth, the transition from intra-uterine to extra-uterine life, and the rotation and change of position of the heart in the thorax with the intimate relation of the thymus make the problem a more difficult one.

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* From the Newly-Born Service of Touro Infirmary and the Department of Pediatrics, School of Medicine, Tulane University of Louisiana.

* Received for publication May 25, 1922.

The plan of measuring the size of the heart, as shown in roentgenographic studies in the adult, are not of much value in the infant. Because of the changes which occur in the thorax at this time of life, it seemed to us that by studying the size of the heart shadow in its relation to the size of the thorax we could make some headway. It was soon shown, however, that the heart shadows varied so that this method would not suffice. We found that there were several distinct types of heart shadows. It may be possible to consider each type of heart shadow separately in a sufficiently large number of cases and secure some definite information, as well as it would be of interest to attempt to ascertain the explanation for these different types.

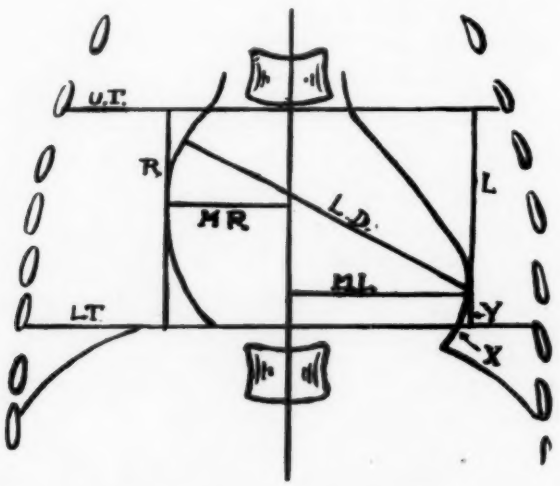

Fig. 1.—Scheme of Measurement.

In this study we employed a method of measurement in which the size of the shadow of the heart was determined by a square within which its shadow could be included. A line, L. T.= lower transverse, is drawn horizontally across the thorax at the level of the upper margin of the diaphragm. A line, U. T. = upper transverse, is drawn in like manner horizontally across the thorax at the level of the upper border of the heart. Two lines, R. and L. R. = right vertical, extending vertically and at right angles from L. T. to U. T. at the right margin of the heart; and L., a similar line at the left margin of the heart; M. = median line drawn to correspond to the center of the vertebral column; M. R. = line from the median line M. to the right margin of the shadow of the heart; M. L. = line from the median line to the left margin of the shadow of the heart; L. D. = largest dimension of the heart, a line drawn from its apex to its base; X = distance from the left border of

the heart shadow to the point of mergence of the heart shadow and the diaphragm; Y = distance on L. from L. T. to left border of shadow of the heart.

Owing to our inability to make exposures at the normal working distance of 2 meters, which distance is used in the adult, we do not attempt to offer the exact measurements of the heart but only the relative size of the heart shadow in its relation to the size of the thorax. The advantage of the 2 meter working distance is that it eliminates the magnification of the shadow and only the normal roentgen ray is employed.

In our observations the technic of making the roentgenograms was as follows: The baby was placed in the recumbent position; a double intensifying screen carrying a duplitized film was used; the opening in the diaphragm (12 cm.) of the tube carriage was centered over the

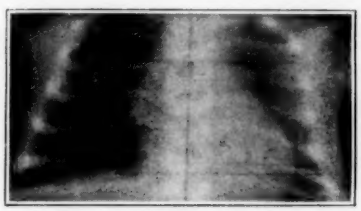

Figure 2

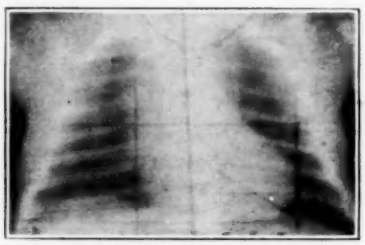

Figure 3

Fig. 2.—Serial No. 1. Radiograph No. 31089. Baby's weight, 8 pounds 12½ ounces. Globular heart, typical. Heart position negative. Thymus to left.

Fig. 3.—Serial No. 7. Radiograph No. 31842. Baby's weight, 7 pounds 10 ounces. Adult heart, typical. Heart to left. Thymus to right and left.

cardiac area at a working distance of 26 inches, and 110 milliamperes of current with a backup of 3½ inches was used and an exposure of one-tenth second made. This time factor was regulated by an automatic timer.

The types of heart and the incidence of each type, as determined by the shadows, were as follows: Globular in twenty-one instances; adult in seven instances; drop in five instances; nutmeg in three instances; square in two instances; round in one instance; unusual in one instance; unclassified in ten instances.

The unclassified heart shadows are so grouped because insufficient clearness of outline would not permit of our conscientiously placing them in any of the groups mentioned.

The globular type showed variations both as to size and position. The smallest was in the smallest infant weighing 3 pounds, 4 ounces, and interesting to relate the position of the heart was exactly centrally

located, the M. L. and M. R. measurements being the same. The largest heart shadow of this type, however, was not found in the largest child presenting this type of heart, there being four infants larger than he. The measurements of the heart shadow did not show any constant relation to either the size of the baby or the size of the thorax. The position of the shadow also was not uniform and while it was usually more to the left than to the right (that is, the M. L. measurement was greater than the M. R. measurement) in two instances these two

Figure 4

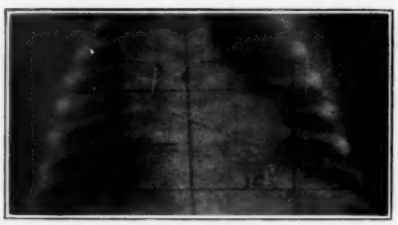

Figure 5

Fig. 4.—Serial No. 11. Radiograph No. 30457. Baby's weight, 8 pounds 6 ounces. Drop heart, typical, also largest. Heart negative. Thymus to left.

Fig. 5.—Serial No. 15. Radiograph No. 30456. Baby's weight, 9 pounds 3 ounces. Nutmeg heart, typical. Heart, negative. Thymus to right.

Figure 6

Figure 7

Fig. 6.—Serial No. 16. Radiograph No. 32668. Baby's weight, 6 pounds 13 ounces. Square heart, typical. Heart, negative. Thymus to right.

Fig. 7.—Serial No. 17. Radiograph No. 32669. Baby's weight, 6 pounds ½ ounce. Round heart, typical. Heart to left. Thymus negative.

measurements were the same, and in another instance the M. R. was greater than the M. L.; the heart shadow being further over to the right of the median line.

The "adult" type also varied in size and position. The smallest heart of this type was found in one of the two smallest infants in this group of the same weight (5 pounds, 4 ounces), though it was in the one whose body measurements, height, weight, chest, abdomen were the larger of the two. Incidentally the thorax in this radiograph showed

evidences suggestive of rickets. The largest shadow of this type was in the largest child of this group of seven. All of the shadows in this group were more to the left than to the right, though the positions varied considerably.

In the "drop" group, variations also occurred. The shadows in this group were more centrally located than in any of the other groups. In two of the five instances the M. R. was greater than the M. L. The smallest shadow in this group was present in the smallest infant of this group, and the largest shadow was seen in the largest infant.

In the "nutmeg" group there was apparently no relation between the size of the shadow and the size of the infant, and there was very little variation in the position of the shadow.

In the two instances in which the shadow was classified as "square" the interesting feature was the enormous area occupied by the shadow. In one instance the shadow was quite centrally located. In both instances the thymus was enlarged especially to the right.

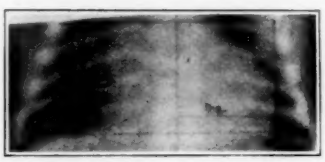

Fig. 8.—Serial No. 18, Radiograph No. 32088. Baby's weight, 9 pounds 12 ounces. Unusual heart. Heart shadow shows a heart markedly dilated to the right, its upper border apparently touches the side of the chest wall in the region of the fourth rib and blends down where the shadow merges with the diaphragm at the ninth rib in the midclavicular line. No way of differentiating thymus shadow.

The instance of the "round" shadow was found in an infant showing roentgenographic evidence in the ribs suggestive of rickets.

The "unusual" heart shadow showed a heart apparently markedly dilated to the right, its upper border seeming to touch the side of the chest wall in the region of the fourth rib and blend down where the shadow merges with the diaphragm at the ninth rib in the midclavicular line.

In the study of the shadow ascribed to the thymus, the following was noted: In connection with the globular hearts the thymic shadow was considered to be not enlarged in nine instances. In twelve instances the shadow was increased in size; in six, the increase was greater to the left side; in five, to the right, and in one equally to the right and left. In the six instances in which the thymic shadow was greater on the left side, in two instances each the heart shadow was increased to the left, increased to the right, and medially located. In the five instances in which the thymic shadow was increased to the right, the

heart shadow was greater to the left in three instances, relatively greater to the right in one instance, and medially located in one instance.

In its relation to the "adult" type of heart the thymic shadow was increased in six instances, and not increased in one instance.

In five instances in which the heart shadow was greater to the left, the thymic shadow was increased to the left in two instances, and to both the right and left in three cases. In the two "adult" type hearts, centrally located, the thymic shadow was increased to the right in one instance and no enlargement was noticeable in the other.

In connection with the "drop" type of heart, in the five instances in which this type was recorded, the thymic shadow was not increased in one instance. In the four instances in which the thymic shadow was increased in size, of the two centrally located heart shadows, one was increased to the right and the other to the left. In the two remaining instances, the one in which the heart shadow was increased to the right the thymic shadow was also increased to the right; and in the other case in which the heart shadow was increased to the left, the thymic shadow was also increased to the left.

In its relation to the "nutmeg" variety of the heart the thymic shadow was increased in one of the three instances, the increase being greater to the right in association with a heart which was relatively greater to the right. The thymic shadow was negative in the other two instances of the "nutmeg" heart, in one case of which the heart shadow was much to the left, and in the other the heart shadow was relatively medially located.

The thymic shadow was enlarged in both instances of the "square" heart, in both of which it was increased to the right. There was no enlargement of the thymus in connection with the "round" heart which was centrally located. In the heart classified as "unusual" no thymic shadow could be differentiated.

We appreciate that conclusions cannot be drawn from the study of so few cases, but we believe that unless the way is opened for such a study and a start made information on this subject will not be forthcoming.

SUMMARY

The summary of our study may be enumerated as follows:

1. The heart shadows vary as to shape, size and position.
2. These variations occur with no relation to the size of the infant.
3. The heart shadows may be grouped in several types according to shape.
4. Variations in size and position occur in each of these types.
5. There is no constant relation between the heart shadow and the shadow of the thymus.

6. The shadow of the thymus is not necessarily influenced by the position of the heart.

7. The shadow of the thymus varies in its size and position independent of the heart shadow and with no relation to the size of the infant.

8. These variations in the shadows of the heart and the thymus can exist without clinical manifestations of disease.

GASTRIC MOTILITY AFTER PYLORIC OBSTRUCTION IN INFANCY*

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AND
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ST. LOUIS

In a ward discussion of pyloric stenosis and pylorospasm in infancy, the question was raised as to the results of operation or nonoperation upon gastric function and motility later on in life. Despite the voluminous literature on the subject of pyloric obstruction from both the medical and surgical standpoints, we were unable to find any data relating to this point, except the statement, which coincided with our own observation, that children who recovered from pyloric stenosis—either with or without operative intervention—seemed to develop normally and to have no ill effects from the early disorder and malnutrition.

In order to obtain some definite data we determined to hunt up some old medical and surgical cases which had been treated in the past at the St. Louis Children's Hospital and make studies of the gastro-intestinal motility, and enlisted the services of Dr. Mills of the department of roentgenology to carry out the roentgen-ray examinations. The children were given a barium and milk meal in the morning on an empty stomach and the passage of the meal was watched with the fluoroscope. From time to time roentgenograms were made for permanent record.

It was decided to study two groups of cases—the nonoperated and the operated—for the purpose of comparison. After four cases in each group were studied we found the results were so uniform that it did not seem worth while to enlarge the series and we are presenting the findings in the eight cases in this paper.

REPORT OF CASES

CASE 1 (47716).—*History.*—B. S., boy, 4 years of age, was first seen July 16, 1917, when 2 months of age. Weight at this time, 4,330 gm. The baby had been breast fed every three hours and when one month of age started to vomit shortly after feedings. The vomiting was projectile in type.

No tumor could be felt. Peristaltic waves were visible. The baby was watched for several days and a diagnosis of pylorospasm was made. As the nutrition was not bad, the baby was placed on atropin and lavage and kept on the breast. There was a slow but steady improvement and the vomiting gradually stopped after a period of several months. The baby was under

* Received for publication, July 25, 1922.

* From the Department of Pediatrics, Washington University School of Medicine and the St. Louis Children's Hospital.

observation for more than a year at an infant welfare center, but had not been seen for two years before the time it was brought back for examination.

Gastro-Intestinal Examination.—The barium meal passed rapidly and in a normal manner through the pylorus. Thirty-five minutes after the meal was given the clearance was active. A roentgenogram taken at four and three-quarters hours (Fig. 1) shows a small amount left in the stomach, but nearly all of the meal in the small intestine, cecum and ascending colon. The conditions as to gastric motility are considered as normal.

CASE 2 (45221).—*History.*—C. B., boy, 4⅓ years of age, came under observation in April, 1917, when 5 months of age. At this time the baby was badly undernourished, weighing 3,900 gm. He had been fed for two months on the breast and since that time on various milk modifications and proprietary foods in an attempt to check the persistent vomiting which had been present since the second or third week of life. The baby had typical projectile vomiting.

Fig. 1.—Case 1 (no operation), four and three-quarters hours after meal. Small amount still in stomach.

No tumor mass could be felt. Peristaltic waves were present. A diagnosis of pylorospasm was made and atropin (1/660 grain) before each feeding was started. The vomiting gradually became less and the general condition of the patient improved slowly but steadily. The baby was kept under observation and treatment for some time.

Gastro-Intestinal Examination.—Under the fluoroscope the barium and malted milk was observed to pass normally through the stomach. Figure 2, taken immediately after the meal had been given, shows the barium already passing through the pylorus, and Figure 3, taken four and one quarter hours later, shows the stomach empty.

CASE 3 (6038).—*History.*—V. S., boy, 8 years of age was treated in the hospital in November and December, 1913. He was brought to the hospital when 10 weeks of age, weighing 5½ pounds. He was said to have weighed 7½ pounds at birth and then gained about two pounds. Near the end of the first month he started to vomit. The vomiting increased steadily and there was a loss of weight. In the hospital it was noted that visible peristalsis, accompanied by projectile vomiting, following each feeding.

Fig. 2.—Case 2 (no operation), shortly after meal. Shows barium passing through pylorus.

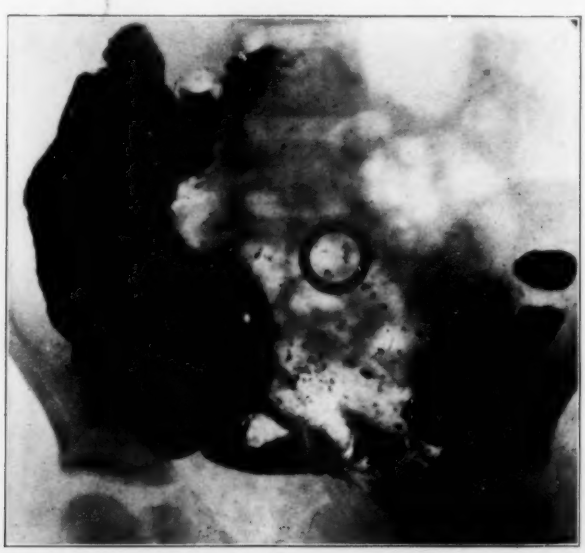

Fig. 3.—Case 2 (no operation), four hours after meal. Stomach empty and barium in small intestine and colon.

No tumor was palpable. A diagnosis of pylorospasm or pyloric stenosis was made and lavage, together with atropin, before each breast feeding was started. There was gradual, slow and rather irregular improvement, vomiting decreasing and increasing again in turn. After seven weeks of hospital treatment, the baby was cared for in the Outpatient Department. After six months the vomiting stopped and by ten months the baby had reached the normal weight line.

Gastro-Intestinal Examination.— In this case the conditions as to gastric motility were likewise found normal. There was no abnormality in the initial motility and the pylorus was definitely canalized, actively and passively. If anything, the motility must be considered very active, as four hours after the meal was taken the stomach was empty and the barium was in the colon.

CASE 4.—*History.*—C. B., girl, 6½ years of age, was a sister of the patient in Case 5. This baby was not treated by us when an infant, but was treated for pyloric stenosis at her home and at another hospital. The history was typical of the condition. The baby was attended by two excellent pediatricians and there is no question as to the diagnosis. She was not operated on, but

Fig. 4.—Case 4 (no operation), four and one quarter hours after meal. Stomach empty and barium almost entirely in colon.

was treated with lavage and atropin. Two years later another child (Case 5) was born and when 4 weeks of age he developed the same condition. This second baby came into the hospital and was operated on, as reported later. The father very kindly consented to the examination of both children. The nonoperated baby had a very difficult first year. She has never been a strong and healthy child and has about the same physical development as the brother, who is two years younger and who was operated on. This is the only case in our experience in which we have evidence that the malnutrition in infancy, which was severe in this case, seemingly affected the development of the child.

Gastro-Intestinal Examination.—Normal conditions were found as to gastric motility and gastric structural conditions. There was a slight initial pyloric spasm lasting for ten minutes observed under the fluoroscope, but no apparent abnormality in the length or width of the pyloric sphincter. There was no suggestion of gastric dilatation or other abnormality. The duodenal cap and pylorus were perfect in formation. Figure 4, at four and one fourth hours, shows the stomach empty and the barium meal in the small intestine, cecum and ascending colon.

CASE 5 (11194).—*History.*—C. B., a boy, aged 4½ years, is the brother of the patient in Case 4. He was breast fed. When 4 weeks of age he developed typical pyloric obstruction with projectile vomiting, starvation stools and visible peristalsis. He was sent to the hospital and failed to improve on routine medical treatment. He was then operated on by Dr. Clopton, who found a thick, olive shaped pyloric tumor with a greatly enlarged stomach. The muscle was incised by the Rammstedt method and measured 7 mm. in thickness. The vomiting stopped after the operation and the child made a good recovery and gained weight rapidly.

Gastro-Intestinal Examination.—Normal conditions were found as to gastric motility and structural conditions. There was no suggestion of gastric dilatation or other abnormality. The pylorus and cap formation were perfect, and under the fluoroscope no abnormality in the length or width of the pyloric sphincter was found. At the end of four and a half hours there was a very

Fig. 5.—Case 7 (operation), shortly after meal. Barium passing through pylorus.

slight amount of the barium meal left in the stomach, but nearly all had passed into the small intestine, cecum and ascending colon.

CASE 6 (15188).—*History.*—J. T., male, 15 months of age, was admitted to the hospital in February, 1920, when one month of age. Birth was normal. When about two weeks old, the baby started to vomit and nearly all of the feedings were regurgitated. On examination visible peristalsis and a palpable tumor were found. The baby failed to respond to medical treatment and ten days after admission was operated on. A moderate size tumor was found which was incised according to the Rammstedt method. The baby stopped vomiting the day following the operation and did not vomit again while in the hospital. The baby started to gain weight rapidly and at the end of the first year the weight was normal. This baby has been under constant observation and has never shown the slightest abnormality in gastric function since the operation.

Fig. 6.—Case 7 (operation), four hours after meal. Stomach empty.

Fig. 7.—Case 8 (operation), shortly after meal. Shows barium passing through pylorus.

Gastric-Intestinal Examination.—On roentgen-ray examination there was no apparent abnormality in the motility with the possible exception of a slight retardation in total motility, as at the end of four and three fourths hours a moderate amount of the barium meal was still in the stomach. The initial motility was normal and the pylorus was definitely canalized. No abnormality was apparent in the width of the pyloric sphincter.

CASE 7 (11416).—*History.*—A. S., girl, 4 years of age, was admitted to the hospital in April, 1917, when 5 weeks of age. She had been breast fed for three weeks. One week after birth vomiting was said to have started. Because of the vomiting the food was changed to an artificial mixture. When brought to the hospital the baby was in bad condition, weighing 3,450 gm. Vomiting was projectile in type; peristaltic waves were present and a tumor mass palpable. Because of the malnutrition, the baby was operated on the day following admission and a large pyloric tumor was found, measuring 1.5 cm. in diameter. The stomach was markedly distended. Vomiting stopped following operation and the baby's condition gradually improved until in a few months the condition of nutrition was normal.

Gastro-Intestinal Examination.—The pylorus was observed to function normally under the fluoroscope, canalization taking place, cap and pyloric formation being perfect. Four hours after the meal was taken, the stomach was practically empty and the barium had passed into the small intestine, cecum and ascending colon. Two pictures of this case are shown, Figure 5, taken shortly after meal was given and showing the pylorus; and another, Figure 6, taken four hours later, showing the meal in the small intestine. Conditions as to gastric motility are considered normal.

CASE 8 (9615).—*History.*—Z. B., boy, 5 years of age, was admitted to the hospital in December, 1915, when 2 months of age. When 3 weeks of age the baby started to vomit and this continued until time of admission. When brought to the hospital the baby was very badly nourished, weighing 3,600 gm., peristaltic waves were present and stools were of the starvation type, but no tumor could be felt. The child was treated medically for three weeks. At first it started to improve, but then started to lose weight and so three weeks after admission was operated on. A typical hard cartilaginous tumor was found, 2 cm. in diameter. This was incised. Following the operation vomiting decreased gradually and in about two weeks the baby started to gain. The child was followed through the outpatient department and in a few months all signs of malnutrition had disappeared.

Gastro-Intestinal Examination.—Under the fluoroscope the pylorus was found to function normally. The pyloric sphincter did not appear thicker than normal and the cap and pyloric formation was perfect. The total gastric motility was normal, the stomach being empty after four hours. Figure 7 was taken shortly after the meal was given and gives a very clear picture of the barium meal passing through the pylorus and a small amount in the small intestine.

DISCUSSION

The gastric motility of eight children, all of whom had been patients with pyloric obstruction in early infancy, was studied and in every instance was found normal. Four of these, aged 4, 4⅓, 6 and 8 years, respectively, had been treated medically, and in four cases, aged 1⅓, 4, 4½ and 5 years, respectively, a pyloroplasty (Rammstedt operation) had been done. In the latter four cases a definite tumor was found, but as to whether the obstruction was due to tumor or simple spasm in the four medically treated cases is, of course, uncertain and therefore

we have classified them as pylorospasm. In each one of these cases persistent vomiting of a projectile type, small stools, visible peristalsis, and malnutrition were present.

At the time of the gastric examination the children were all in a good condition of nutrition and with one exception (Case 4) they had developed normally after overcoming the trouble in early infancy. All belonged to the "sthenic" type of habitus, as classified by Mills.[1]

There is little data in regard to gastric motility in children. In the "sthenic" type of habitus in adults the stomach usually empties in from four to five hours, the average time in round numbers in this type, as determined by Mills[2] in a series of 481 cases, being four hours and forty-five minutes. Interestingly, in asthenic adults complete gastric motility was found by the same author definitely slower, the average time of such total emptying being five hours and forty-five minutes in 118 cases. It would be very interesting if comparable figures of the time of complete gastric motility in different types of children were available. Figures of this sort are a necessity if such time varies anything like what it does in adults. In adults, as determined by Mills, the intermediate hyposthenic type of habitus has a total motility of five hours and thirty minutes as found in a series of 354 subjects and the extreme hypersthenic type, persons of massive physique, high stomachs, and rapid general alimentary motility, has the most rapid gastric motility, four hours and fifteen minutes in a series of forty-seven cases. A factor also to be taken into consideration in studies of complete gastric motility in different types, certainly in adults and also in children by inference, is the incidence of the various types of physique. If one or two intermediate types are, as is actually the case, numerically in marked preponderance as are the sthenic and hyposthenic, the time of complete gastric motility in these types should be considered the average or "normal" time, and those of the less frequently occurring hypersthenic and asthenic types as exceptions; yet whose motility time is to be judged by that of similar persons. Figures as to the incidence of types also compiled by Mills from observations on 1,000 adults without known organic or marked functional disturbances are as follows: Hypersthenic habitus, forty-seven, 4.7 per cent.; sthenic habitus, 481, 48.1 per cent.; hyposthenic habitus, 354, 35.4 per cent., and asthenic habitus, 118, 11.8 per cent.[3] Recently Sauer, Minsk and Alexander[4]

1. Mills, R. W.: Am. J. Roentgenology **4**:155 (April) 1917.
2. Mills, R. W.: Tr. Am. Gastro-enterological Assoc. **36**:47, 1918.
3. As an aside, the variation in the incidence of different types of habitus should be taken into consideration in many other conditions, such as the relative occurrence of different diseases in different types; for example, tuberculosis, as occurring in asthenics. Since the asthenic type is comparatively rare, tuberculosis is very much more predilected in such type than is apparent at first sight.
4. Sauer, Minsk and Alexander: J. A. M. A. **79**:184 (July 19) 1922.

reported considerable slowing of the gastric motility in children with anorexia, and for comparison cite the cases of twelve children with good appetite of the "sthenic" habitus. In these children the stomach was empty in one instance by three and one-half hours; in four by four hours; in two by four and one-half hours, and in the remaining five by five hours. In five of our cases the stomach was empty by four and one-half hours or less and in the remaining three cases only a very slight amount was left by this time. Our figures, therefore, fall well within the limits of what may be considered as normal gastric motility. In children of hyposthenic or asthenic habitus the stomach frequently is not emptied before six or seven hours after the meal is given.

It was of particular interest to find that there was no difference between the cases of pyloric obstruction treated medically and those treated surgically. This was the original point raised and our findings lead us to conclude that the late or end-results cannot be taken into consideration in a given case of pyloric obstruction in infancy, in deciding for or against operation.

CONCLUSIONS

The gastric motility was studied in eight children from 1½ to 8 years of age, who had been treated for pyloric obstruction in early infancy. Four had been treated medically and four surgically (Rammstedt operation). In every instance conditions as to gastric motility were found normal.

THE RATE OF SECRETION OF BREAST MILK*

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The problems involved in breast feeding have been studied long and exhaustively and there remains little to be said on the subject. There is one point, however, on which medical writers are indefinite, that is, the length of time which a baby should be allowed to stay at the breast at each feeding.

Twenty minutes at each nursing is usually taught as an absolute rule to nurses and physicians, and by them transmitted to the mother. This tradition has been handed down from generation to generation and is seldom questioned.

Few textbooks mention definitely the nursing time, merely stating that it should not be prolonged beyond 20 minutes, and that often from ten to fifteen minutes will suffice. Many authors state that the baby may nurse until satisfied or sleepy. A few hint at what we have found to be the real facts, but are not sufficiently definite.

Still says, "The time taken at the breast should be about 15 minutes. Some infants suck so rapidly that they will empty breasts in less than ten minutes, with resulting colic and vomiting. To prevent this mothers should regulate the flow by compressing the nipple with the hand."

It seems to us that the colic and vomiting described may more properly be attributed to overfeeding than to rapid feeding.

Kerley says, "Weighing the baby at intervals of from three to five minutes and noting gain has shown that from three to four ounces, which may represent the child's stomach capacity, may be obtained in two, three or five minutes. From a free, full breast a good nurser will take one ounce in one minute. The idea that a nursing infant will take no more than is good for him is the fruit of inexperience."

Grulee says, "As an arbitrary rule it is not well to leave the baby at the breast longer than from fifteen to twenty minutes. In restricting the time at the breast we must take in consideration that in the first five minutes the child gets as much as in the next ten minutes."

This study was undertaken to try to ascertain the facts in this matter. The objects in mind were: (1) to determine the rate at which the baby gets the milk from the breast; (2) to determine the average time which is taken to obtain the entire feeding.

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* Read before the American Pediatric Society, May 1, 1922.

In order to ascertain these points we have used the method of "fractional weighing," that is, weighing a number of babies at frequent intervals during nursing. The increase in weight during each interval represents the milk secreted. By using a scale which weighs accurately to ¼ ounces quite correct figures are obtained.

It may fairly be said, it seems to us, that it is not desirable to let a baby nurse after he really stops getting milk from the breast. The child who sucks will swallow, and if there is no milk he will swallow air. This increases his gastric distension and predisposes to vomiting and colic, as was pointed out by Smith and LeWald [1] several years ago.

Prolonged nursing is bad for the baby also because it means fostering the habit of chewing the nipple when no milk is being secreted.

In the second place, the saving of the mother's time is important. The following examples show what this may mean:

A mother had two babies eleven years apart. During the early months the first was nursed twenty minutes every two hours, or 200 minutes a day. The second was nursed five minutes every four hours, or twenty-five minutes a day. The mother saved 175 minutes or nearly three hours of her time a day, and the second baby did perfectly well.

Another mother nursed her first child twenty minutes every two hours, nine feedings, or 180 minutes a day. At ten weeks the child developed eczema, was cut down to forty seconds every four hours, five feedings, or 200 seconds a day, about one-sixtieth of the first plan. This mother had such an abundant and rapid milk secretion that the baby still gained on the very short nursing periods.

In addition, the sparing of the mother's nervous system has to be considered. A great many women complain that the prolongation of the nursing to fifteen or twenty minutes makes them exceedingly nervous, while they do not mind short nursings at all.

It is also bad for the nipple to have the baby chew on it longer than is necessary.[2]

The point may be raised that the supply of breast milk is more likely to fail if the nursings are shortened too much. This point has been carefully noted by one of us for several years, and breast milk does not seem to fail more quicky on relatively short nursings than it did on the older principle of prolonged ones.

Another possible objection may be that it has been found by analysis that the breast milk taken at the latter part of the nursing (strippings)

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1. Smith, C. H., and LeWald, L. T.: The Influence of Posture on Digestion in Infancy, Am. J. Dis. Child. **9**:261 (April) 1915.

2. In discussing this paper, Dr. R. S. Haynes said that the incidence of cracked nipples had been much reduced at The Sloane Maternity Hospital since the nursing time had been cut down from twenty minutes to eight or ten minutes.

is richest in fat, and that, therefore, he child's nursing time should not be reduced lest he lose this necessary part of the milk. This is doubtless true, but does not excuse leaving the baby at a breast which has been emptied, and from which he is getting no milk whatever.

The method of "fractional weighing" used in this study is not a new one, since it has long been used as a routine by many clinicians for determining the length of time a baby should be allowed to nurse, and for deciding whether he needs one breast or both for each feeding.

We have used the two minute interval in the majority of the cases studied. Some observations have been made at one minute intervals, but this gives too short a time between the weighings for the baby to get a good start. The time has been taken from the instant nursing began, and the baby has been removed from the breast promptly at the end of two minutes whether he has nursed vigorously or fitfully. Few of the babies object to being interrupted for the few seconds which it takes to weigh them. The nursings have been continued on one breast until the baby obtained nothing during one or two periods of two minutes, or until he refused to nurse any more; a few were stopped when vomiting occurred. In most cases the baby was offered the second breast, and allowed to nurse until the weight remained stationary or until the baby refused to continue.

It is obvious that there are many factors which must be considered in studying the results obtained, such as the age of the baby, his weight, whether he is of average size, overweight or underweight; his vigor and his temperament. Furthermore, the time of day is of no small importance. The morning nursings give a larger amount than those taken in the afternoon, as a rule. A great many of our observations were made in the out-patient department between 2 and 5 o'clock, when the milk supply is not at its best.

The condition of the breast, its size and fullness, the variation between the two sides, and whether one breast or both are necessary, all bear directly upon the figures obtained. If the infant is thriving and the supply of milk bids fair to continue, we must interpret a single poor nursing in a different light from a similar one obtained from a definitely failing breast. The matter of added bottles also make some difference in the manner in which baby does his share of the nursing. If the breast milk is growing scanty the baby will often refuse to nurse well, preferring to wait for the bottle which he has learned to expect.

We find that our observations fall naturally into four groups according to the amount obtained in relation to the wight of the child. It is not possible to compare the nursing curve of a large child who gets 6 or 7 ounces from one breast with that of a 6 pound baby who gets only ½ ounce from two breasts.

We have assumed that a good feeding is one in which a baby gets about 0.4 ounce (or more) per pound of body weight.[3] But since we are dealing with breast milk a somewhat smaller amount, 0.33 ounces per pound, has been assumed to be adequate.

The observations have been grouped as follows:

1. Adequate feeding from one breast (more than 0.33 ounce milk per pound). Twenty per cent. of our observations fall into this class.

2. Adequate feedings from both breasts. Twenty-five per cent. are in this class.

3. Fair feedings from the two breasts (from 0.25 to 0.33 ounce of milk per pound). These babies were mostly fed on the breast alone and were doing well; the comparatively poor nursing was probably only due to the time of day or other factors. Twenty per cent. are in this class.

4. Poor feedings. These babies obtained less than 0.25 ounce of milk per pound from two breasts. They make up 35 per cent. of the observations. This group contained the largest number of babies who were given bottle or cereal in addition to the breast (fifteen of the thirty-five). The milk supply was failing in a good many cases.

A mass of figures like these can be best studied by the graph method. We have plotted all our observations separately—but have shown only a few typical feedings (Fig. 4) and the curves of averages (Figs. 1, 2 and 3) of the various groups. Each average curve has been continued as long as any individual baby obtained milk. This does not mean that all the group got milk to the point represented by the end of the curve. The average time after which no more milk was obtained ("average emptying time" of the breast) is plotted on each line as a circle surrounding a dot.

In studying the curves in each group, it is necessary again to subdivide according to the size of the baby. We have taken weight as the criterion rather than age. As a matter of fact, this is a fair thing to do because more of the babies have been over weight for their age rather than under. We have divided them into: (1) those under 9 pounds; (2) those from 9 to 12 pounds; (3) those from 12 to 15 pounds, and (4) those over 15 pounds.

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3. This amount was derived from the following: In the early months the child needs 3 ounces of fluid per pound of body weight (one-fifth of his weight) and seven feedings: $\frac{\text{Wt.} \times 3}{7} = 0.4$ In the middle months the child needs 2½ ounces per pound (from one-sixteenth to one-seventeenth of his weight) and from five to six feedings. $\frac{\text{Wt.} \times 2\frac{1}{2}}{6} = 0.4+$. In the latter months he will take 2 ounces per pound (one-eighth of his weight) and five feedings $\frac{\text{Wt.} \times 2}{5} = 0.4$. Therefore, 0.4 ounce of fluid per pound is about the amount needed for all babies.

This gives three or four curves on each chart, one for each group of babies by weight. Some of them contain only a few observations, but the individual variations from the average are not great.

The twenty observations in which the baby obtained an adequate feeding from one breast (Table 1 and Fig. 1) were made on sixteen different babies. All but three were being fed on breast alone.

The curves (Fig. 1) show a distinct similarity—a rapid rise in the

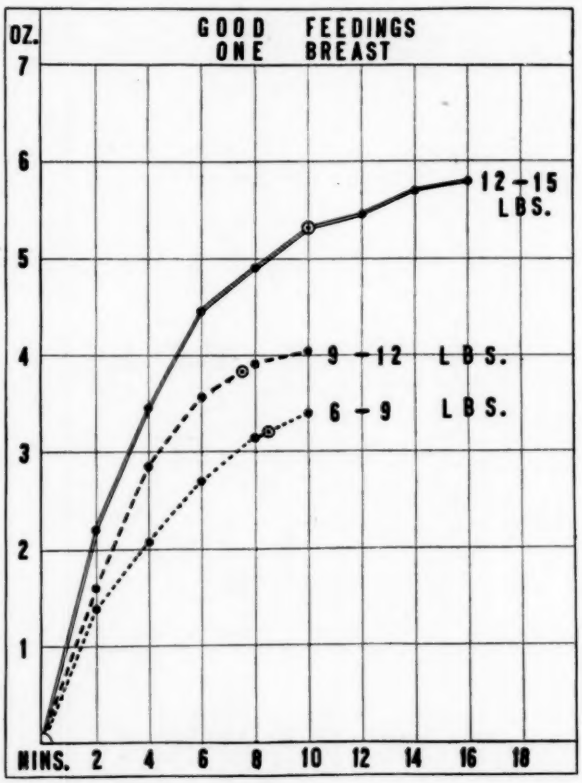

Fig. 1.—Curves obtained by averaging observations in Table 1, grouped according to the weight of the babies. Each curve is continued as long as any baby obtained milk. Average time after which no more milk was obtained is shown by circle surrounding dot.

first three periods, followed by a very small gain in each succeeding one. In all three the baby obtained about 40 per cent of the total amount in the first two minutes; from 60 to 70 per cent. in the first four minutes; from 75 to 85 per cent. in the first six minutes

The average emptying time is shown as 8.5 and 7.6 minutes, respectively, in the two lower curves. None of the babies obtained any milk after ten minutes. Of the larger infants (from 12 to 15 pounds) one obtained some milk up to fourteen minutes and one up

TABLE 1.—Good Feedings Single Breast

Observation Number	Bottle	Cereal	Weight, Pounds	Age	Ounces of Milk Obtained in Each 2 Minute Period								Total, Oz.	Ounces Milk per Pound
					2	4	6	8	10	12	14	16		
1	..	..	6¼	7 weeks	0.5	0.5	0.75	0.75	0	....	....	....	2.5	0.4
2	+	..	6½	7 weeks	1.75	0.75	0.5	0.25	0.25	0	....	....	3.5	0.55
3	..	..	7	1 month	2	0.75	0.25	Ref.	....	....	....	....	3	0.43
4	+	..	8	3 weeks	1.25	0.75	1	0.75	0.25	Ref.	....	....	4	0.5
5	..	..	9¾	1 month	1.75	1	0.75	0.25	0	0	....	....	3.75	0.375
6	..	..	9¾	2 weeks	2.5	1	0.25	Ref.	....	....	....	....	3.75	0.375
7	..	..	10¼	6 weeks	2	1	0.5	Ref.	....	....	....	....	3.5	0.35
8	..	..	10¼	6 weeks	2	1.5	0.5	Ref.	....	....	....	....	4	0.4
9	..	..	10¼	3 weeks	1	1.5	0.5	1	Ref.	....	....	....	4	0.4
10	..	..	10½	6 weeks	1	1	1.5	0.5	1.25	Ref.	....	....	5.25	0.48
11	..	..	11	8 weeks	0.5	1	1	1	0.5	0	....	....	4	0.37
12	..	..	10¾	6 weeks	2	1.5	0.5	0.5	St.	....	....	....	4.5	0.41
13	..	..	10¾	6 weeks	2	1.5	0.5	Ref.	....	....	....	....	4	0.37
14	..	..	11¾	2½ months	1.25	1.5	1.25	1	Ref.	....	....	....	5	0.42
15	..	..	12¾	2 months	2	1.25	1	Ref.	....	....	....	....	4.25	0.34
16	..	..	13	2½ months	0.5	1.75	1	0.25	0.25	0.5	0.75	0.5 R.	5.5	0.42
17	..	..	13¾	4 weeks	2	1.75	2.5	1	Ref.	....	....	....	7.25	0.53
18	+	..	14½	7 months	3.5	1	0	0.5	1.25	0	....	....	6.25	0.43
19	..	..	15	5 months	3	1	1	0	....	....	....	....	5	0.34
20	..	..	15¼	3 months	2.25	0.75	0.5	1	1	0.25	0.75	0	7	0.46

to sixteen minutes, which prolongs this particular curve and makes the average emptying time ten minutes. Two of these children, however, emptied the breast in six minutes. Most of these babies are under two months old, and all but two weighed less than 15 pounds.

Figure 2 shows the nursings which were adequate from two breasts. In three of the groups from 58 to 68 per cent. was obtained from the first breast. In one group (from 9 to 12 pounds) about 50 per

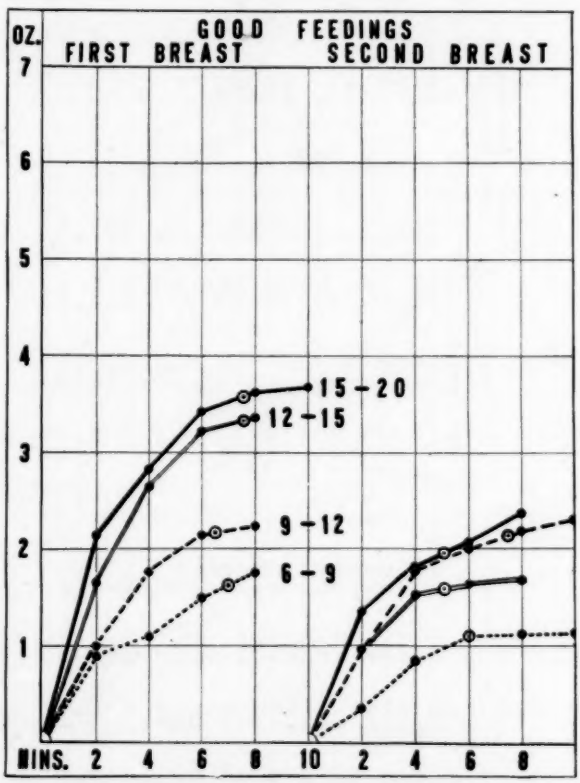

Fig. 2.—Curves showing average of observations from Table 2. Curves representing average amounts from second breast are plotted in broken, double, or solid lines to correspond to those of first breast. Average emptying time shown by circle and dot.

cent. came from each side. The smaller nursing from the second breast, is probably due to the fact that the baby loses the first edge of his appetite after he has obtained some food.

The secretion in the individual breasts follows the general rule. Most of the milk is obtained in the first four minutes (from 65 to 80 per cent.) and the largest amount in a single period is in the first two minutes (from 45 to 58 per cent.). The average emptying time is from 6½ to 7½ minutes.

TABLE 2.—Good Feedings Both Breasts

Observation Number	Bottle	Cereal	Weight, Pounds	Age	Ounces of Milk Obtained in Each 2 Minute Period						Total First Breast	Ounces of Milk Obtained in Each 2 Minute Period						Total Second Breast	Total Both Breasts	Ounces Milk per Pound
					2	4	6	8	10	12		2	4	6	8	10	12			
21	+	..	6¾	3 wk.	0.5	0.25	0.25	0.5	0	....	1.5	0.5	0.25	0	0.25	0.25	0	1.25	2.75	0.4
22	..	..	7½	1 mo.	1.75	0	0	....	....	....	1.75	0.25	0.5	1	0	....	....	1.75	3.5	0.46
23	..	..	7½	5 mo.	0.5	0.25	0.25	0.25	0	....	1.25	0.5	0.5	0.25	V.	....	....	1.25	2.5	0.34
24	..	..	8	3 wk.	0.75	0.25	0.5	0.25	0	....	1.75	0.75	0.5	0	....	....	....	1.25	3	0.375
25	..	..	8	1 mo.	1	0.25	0.5	0.25	Ref.	....	2	0	0.75	Ref.	....	....	....	0.75	2.75	0.34
26	..	..	9¾	2 mo.	1.25	1	0	0.5	0	0	2.75	0.75	1	0	0.5	0	....	2.25	5	0.5
27	..	..	9¼	1½ mo.	0.5	0	0.25	0.25	0	....	1	0.5	1	0.25	0	0.5	0	2.25	3.25	0.38
28	+	..	9¼	6 wk.	1	0.25	0.5	0	....	....	1.75	0.25	0.5	0.5	0.5	0	....	1.75	3.5	0.4
29	..	..	10	2½ mo.	1.25	0.5	0.25	0	....	....	2	1	0.75	Ref.	....	....	....	1.75	3.75	0.38
30	..	..	10	11 wk.	1	1.5	0	....	....	....	2.5	1.5	1.5	0.5	Ref.	....	....	3.5	6	0.6
31	..	..	10¾	3½ mo.	0.75	0.75	0.5	0	....	....	2	0.75	0.5	0.5	0.25	0.25	Ref.	2.25	4.25	0.4
32	+	..	11	5 mo.	1	1.5	0.5	0	....	....	3	1.5	0.5	0	0	....	....	2	5	0.45
33	..	..	11¾	2½ mo.	1.25	0.5	0.25	0	....	....	2	1.25	1.25	1	0.25	0.5	0	4.25	6.25	0.54
34	..	..	12	3 mo.	1.25	0.75	0.5	0.25	0.5	0	3.25	0.75	0.25	0.25	0.25	V.	....	1.5	4.75	0.4
35	..	..	13¼	3½ mo.	1	1.5	0	....	....	....	2.5	1	1.25	0	....	....	....	2.25	4.75	0.36
36	..	..	13¼	3 mo.	1.75	1.25	0.75	0	....	....	3.75	0.5	0.5	0.25	0	....	....	1.25	5	0.385
37	..	..	13¾	4 mo.	1	0.75	0.5	0.25	0	....	2.5	1.25	1.25	0	....	....	....	2.5	5	0.37
38	..	..	13¼	3 mo.	2	1.75	0	....	....	....	3.75	1	0	....	....	....	....	1	4.75	0.35
39	..	..	14½	5 mo.	3.5	0	1	0	....	....	4.5	2	1	0.5	St.	....	....	3.5	8	0.55
40	..	..	14¾	3 mo.	2	1.25	0.5	0.5	0	....	4.25	0.25	0.25	0	....	....	....	0.5	4.75	0.33
41	+	..	15½	4½ mo.	2	1	0.5	0	....	....	3.5	1	0.75	0	....	....	....	1.75	5.25	0.34
42	..	..	15½	3 mo.	1.75	0.25	0.5	0.25	0	1.25	4	0.5	0.75	0.25	0.5	0	0	2	6	0.4
43	..	..	16¾	5 mo.	1.5	0 5	1.25	0.75	0.25	0	4.25	2	0	....	....	....	....	2	6.25	0.37
44	..	+	18¼	7 mo.	3.5	1.75	0.75	0	....	....	6	0.75	0.75	0	....	....	....	1.5	7.5	0.4
45	+	..	19¾	6 mo.	2	1	0	....	....	....	3	2.5	0	0.75	1	0	....	4.25	7.25	0.37

From the second breast again from 70 to 80 per cent. was obtained in the first four minutes. The variation of individual nursings is from two minutes to ten minutes. Most of the babies had emptied the breast in from six to eight minutes. The average time is from five to seven and one half minutes. These babies who needed two breasts are, in general, somewhat older than the first group.

The fair nursings (Table 3 and Fig. 3) include twenty observations on babies, 60 per cent. of whom were being fed on breast alone and

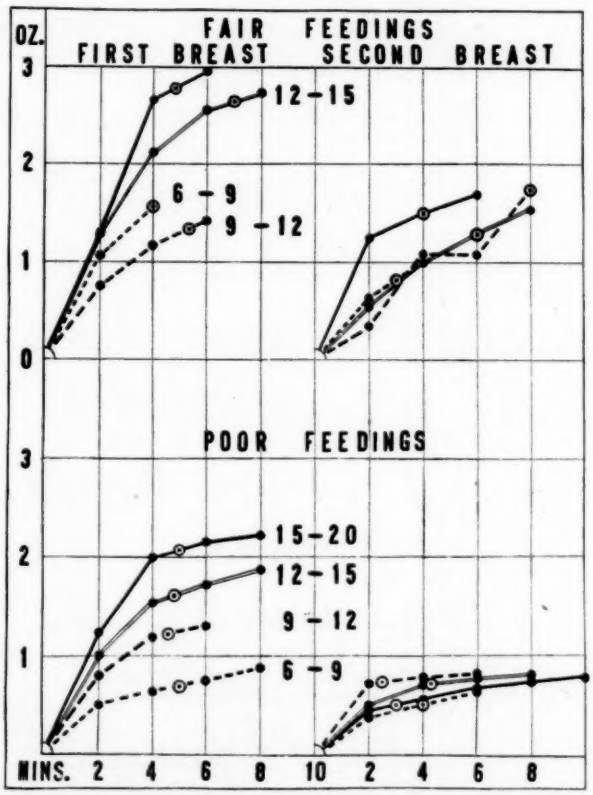

Fig. 3.—Curves showing averages of observations from Tables 3 and 4. Same conventions as Figures 1 and 2.

were doing well. The curves of the first breast show a similar form to the good nursings except that they are shorter, nearly all having finished at six minutes. The average emptying time (four, four and eight-tenths and five and three-tenths minutes) is short except in one group, (seven minutes).

The second breast curves are somewhat more irregular but are based on only a few nursings, since several of these babies refused the second breast. The emptying time is short in most cases.

TABLE 3.—Fair Feedings Both Breasts

Observation Number	Bottle	Cereal	Weight, Pounds	Age	Ounces of Milk Obtained in Each 2 Minute Period						Total First Breast	Ounces of Milk Obtained in Each 2 Minute Period						Total Second Breast	Total Both Breasts	Ounces Milk per Pound
					2	4	6	8	10	12		2	4	6	8	10	12			
46	+	..	8	3 wk.	0.75	0.25	0	....	....	....	1	0.75	0.75	0	....	....	....	1.5	2.5	0.31
47	..	..	8½	3 wk.	1.5	0.75	0	....	....	....	2.25	0.5	0	....	....	....	....	0.5	2.75	0.32
48	..	..	10	1 mo.	0.75	0.75	0.5	0	....	....	2	0	0.5	0	0.75	0	....	1.25	3.25	0.325
49	+	..	10½	2 mo.	0.75	0.5	0	....	....	....	1.25	0.25	0.75	0	0.5	0	....	1.5	2.75	0.26
50	..	..	11¾	2 mo.	0.75	0	0.25	0	....	....	1	0.75	1	0	0.75	Ref.	....	2.5	3.5	0.30
51	..	..	12	3 mo.	1	0.5	0.5	0.5	0.5	Ref.	3	Ref.	....	....	....	....	....	Ref.	3	0.25
52	..	..	12½	2½ mo.	1.25	1	0.25	0.25	0	....	2.75	0.25	0.25	0	....	....	....	0.5	3.25	0.27
53	..	..	12¼	3¼ mo.	1	1.25	1.25	Ref.	....	....	3.5	Ref.	....	....	....	....	....	Ref.	3.5	0.28
54	..	..	12½	2½ mo.	0	0.5	0.25	0.25	0	0	1	0.75	0.5	0.75	0.5	0	0	2.5	3.5	0.28
55	+	..	12¾	5½ mo.	1	0.5	0.5	0.25	St.	....	2.25	1	0.75	0	0.5	St.	....	2.25	4.5	0.35
56	+	..	13	3 mo.	2	1.5	0.25	0	....	....	3.75	Ref.	....	....	....	....	....	Ref.	3.75	0.29
57	..	..	13½	3½ mo.	2	1.25	0	....	....	....	3.25	0	....	....	....	....	....	0	3.25	0.25
58	..	..	13½	4 mo.	1	0.75	0.75	0.75	....	....	3.25	0.25	0	....	....	....	....	0.25	3.5	0.27
59	..	..	13¾	3 mo.	0.75	1	0	....	....	....	1.75	0.5	0.75	0.75	0.25	0	....	2.25	4	0.30
60	..	+	14	7 mo.	2.75	0.25	0.5	0.25	Ref.	....	3.75	0	....	....	....	....	....	0	3.75	0.27
61	+	..	15	4 mo.	1.75	0.5	0	....	....	....	2.25	1.5	0	....	....	....	....	1.5	3.75	0.25
62	+	..	15	4 mo.	1.5	1	0	....	....	....	2.5	1.5	0.5	0	....	....	....	2	4.5	0.3
63	+	..	15½	5 mo.	1.5	2	0	....	....	....	3.5	1.25	0.25	0.25	0	....	....	1.75	5.25	0.34
64	+	..	16	7 mo.	1	2	1	0	....	....	4	1	0	0	....	....	....	1	5	0.31
65	..	..	18	8½ mo.	0.75	1.25	0.5	0	....	....	2.5	1	0.5	0.75	0	....	....	2.25	4.75	0.26

TABLE 4.—Poor Feedings Both Breasts

Observation Number	Bottle	Cereal	Weight, Pounds	Age	Ounces of Milk Obtained in Each 2 Minute Period						Total First Breast	Ounces of Milk Obtained in Each 2 Minute Period						Total Second Breast	Total Both Breasts	Ounces Milk per Pound
					2	4	6	8	10	12		2	4	6	8	10	12			
66	+	..	8¼	1 mo.	0.75	0	0	....	....	....	0.75	0.25	0.25	0.25	....	....	....	0.75	1.5	0.19
67	..	..	8¼	1 wk.	0.25	0.25	0.25	0.25	0	0	1	0.5	0	0	....	....	....	0.5	1.5	0.18
68	+	..	9¼	2 mo.	0.75	0.25	Ref.	....	....	....	1	0.5	0	....	....	....	....	0.5	1.5	0.17
69	..	..	9½	1 mo.	0.5	0	....	....	....	....	0.5	1.25	0	....	....	....	....	1.25	1.75	0.18
70	..	..	9¾	6 wk.	0.75	0.5	0.5	0	....	....	1.75	0.5	0	....	....	....	....	0.5	2.25	0.23
71	+	..	10¼	2 mo.	0.75	0.25	0.25	0	....	....	1.25	0.5	0	....	....	....	....	0.5	1.75	0.17
72	..	..	10¼	1 mo.	0.5	0.25	0.25	0	....	....	1	1.5	0	....	....	....	....	1.5	2.5	0.23
73	..	..	10¾	2½ mo.	1.25	0.25	0	....	....	....	1.5	0.5	0.5	Ref.	....	....	....	1	2.5	0.23
74	..	..	11¼	2 mo.	0.5	0.25	0	....	....	....	0.75	0.75	Ref.	....	....	....	....	0.75	1.5	0.13
75	..	..	11¼	2 mo.	1	0.75	0.25	0	....	....	2	0.25	0	0 .25	0	....	....	0.5	2.5	0.225
76	..	..	11¾	4 mo.	1.25	0.5	0	....	....	....	1.75	Ref.	....	....	....	....	....	Ref.	1.75	0.15
77	..	..	12	3 mo.	2	0.25	0	....	....	....	2.25	0	0.25	0	....	....	....	0.25	2.5	0.21
78	+	..	12½	3 mo.	1	0.5	0.5	0	....	....	2	0.25	0	0	....	....	....	0.25	2.25	0.18
79	..	..	12½	2 mo.	1.25	0	Ref.	....	....	....	1.25	0.75	0.5	0	0.25	0	0	1.5	2.75	0.22
80	+	..	12½	4 mo.	1	0	0.5	0	....	....	1.5	0.5	0.25	0	....	....	....	0.75	2.25	0.175
81	+	..	13	3 mo.	0.5	1.5	0	0	....	....	2	0.5	0.25	0	....	....	....	0.75	2.75	0.21
82	..	..	13¾	5 mo.	0.5	0.25	0.25	0.5	0	....	1.5	0.25	0.25	0.25	0	....	....	0.75	2.25	0.165
83	..	..	14½	3 mo.	0.75	1.25	0	0	....	....	2	1.25	0	0	....	....	....	1.2 5	3.25	0.22
84	+	..	15	4 mo.	1	0.5	0	....	....	....	1.5	1	0	0	....	....	....	1	2.5	0.16
85	+	..	15	4 mo.	0.75	0.25	0	....	....	....	1	0.5	0.75	0	....	....	....	1.25	2.25	0.15
86	+	..	15	4 mo.	1.25	0.5	0	....	....	....	1.75	0.75	0.25	0.25	Ref.	....	....	1.25	3	0.2
87	..	..	15½	7¼ mo.	2.5	0.75	0	....	....	....	3.25	0	0	....	....	....	....	0	3.25	0.21
88	+	..	15¾	3 mo.	0.75	0.5	0.25	0.5	0.5	0	2.5	0.5	0.25	0	....	....	....	0.75	3.25	0.21
89	..	..	16	4½ mo.	0.5	0.5	0.5	....	....	....	1.5	0.25	1.25	0.5	....	....	....	2	3.5	0.21
90	..	..	16¼	3½ mo.	1.5	0.75	....	....	....	....	2.25	0.75	0	0	....	....	....	0.75	3	0.187
91	..	..	16½	6 mo.	0.75	0.5	0.25	0.25	0	....	1.75	0.5	0.25	0.25	0.5	0.5	0	2	3.75	0.23
92	..	..	16¾	4 mo.	2.25	0.5	0	....	....	....	2.75	0.5	0	0.5	0	....	....	1	3.75	0.2
93	+	..	17¼	6 mo.	1.25	0.5	0	0.5	0	0	2.25	0.25	0	0	0	....	....	0.25	2.5	0.145
94	..	..	17¼	7 mo.	1.5	1.75	0.25	0	....	....	3.5	0.5	0	0	....	....	....	0.5	4	0.23
95	..	..	17¼	5 mo.	1.25	0.75	0	....	....	....	2	0.5	0.25	0.25	....	....	....	1	3	0.177
96	..	..	17¼	5 mo.	1.5	0.75	1.25	0	....	....	3.5	Ref.	....	....	....	....	....	Ref.	3.5	0.2
97	..	+	17¼	11 mo.	1.25	1	0	0	....	....	2.25	Vom.	....	....	....	....	....	Vom.	2.25	0.13
98	..	+	17½	4 mo.	0.5	1.5	0.25	0	....	....	2.25	0.75	0	....	....	....	....	0.75	3	0.17
99	+	..	18¼	6 mo.	0.75	1.25	0	....	....	....	2	Ref.	....	....	....	....	....	Ref.	2	0.11
100	..	+	18¾	8 mo.	1.5	0.75	0	....	....	....	2.25	0.75	0	....	....	....	....	0.75	3	0.17

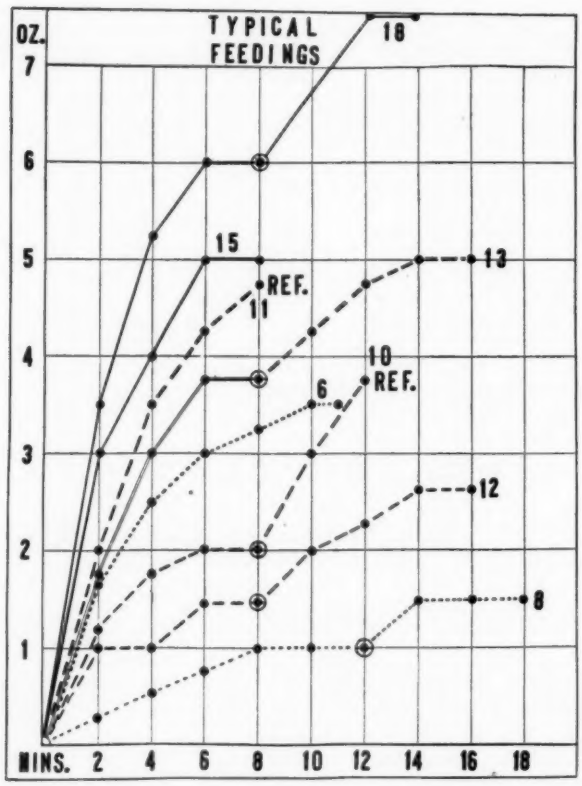

Fig. 4.—Some typical feedings. The numbers at end of each curve represent the weight of the baby. The point at which the second breast was begun is shown by the large circle. Various types of feedings are plotted. The curve marked 8 is a poor feeding, 1½ ounces from two breasts—and is very unusual because the milk was obtained at a steady rate from the first breast. The curve marked 12 is a fair feeding, 2¾ ounces from two breasts—rather irregularly obtained. The curve marked 10 is a good feeding, 3¾ ounces from two breasts. After twelve minutes the baby refused to nurse. The curve marked 6 is a good feeding, 3½ ounces from one breast, or 5.8 ounces per pound—this baby would have been as well off if he had been stopped at six minutes—with three ounces. Curve marked 13 is a good feeding from two breasts—3¾ ounces from first, 1¼ ounces from second, 3.85 ounces per pound. Curve marked 11 is a very good feeding from an abundant breast, 4¾ ounces in eight minutes. The baby refused to continue after eight minutes. This mother regularly supplied from four to five ounces in six minutes, on many observations. Curve marked 15 is a fair feeding but a baby who was doing very well. He probably obtained more at other nursings, since he obtained 5 ounces in six minutes. Curve 18—six ounces in six minutes, 1½ ounces from second breast. A very large thriving baby.

The poor feedings (Table 4, Fig. 3) again show the same general features. On the first breast the babies got from 80 to 90 per cent. of the milk in four minutes. The average emptying times were from four and five-tenths to five minutes.

The second breasts gave very poor feedings to all these babies, less than an ounce as a rule, most of which was obtained in two minutes. The average emptying time is very short (from two and four-tenths to four and two-tenths minutes). Only one baby obtained any milk after eight minutes and only three after six minutes. This group contains more older and larger babies when the milk would naturally be failing.

SUMMARY

From the above it is evident that nursing infants obtain the greater part of their feeding of breast milk in the first few minutes, from 40 to 60 per cent. in the first two minutes, and from 60 to 85 per cent. in the first four minutes. This holds true whether the supply is abundant, moderate or scanty. After eight minutes very few babies get any milk whatever. Only seventeen of our observations show any increase in weight after eight minutes; fourteen of these were from Tables 1 and 2—good feedings; only three babies obtained milk after ten minutes. A few larger, vigorous infants nursing from an abundant supply, may get small amounts of milk up to sixteen minutes.

The babies who need both breasts usually get less from the second than from the first side, except when one regularly yields a better supply. The rate at which a baby gets milk from the second breast is similar to that of the first breast: i.e., from 40 to 60 per cent. in the first two minutes and from 65 to 85 per cent. in the first four minutes. After that very little is obtained. The time after which a baby gets no more milk is usually shorter on the second breast than on the first.

The poor feedings have been completed in a shorter time than the good ones. When the breast supply is evidently failing, the baby gets all he can in from three to five minutes, as a rule. It does no good to leave a baby a longer time (from fifteen to twenty minutes) at a failing breast in the hope of eking out a meager supply.

If a baby empties the breast in from five to eight minutes and shows no signs of discomfort from an adequate feeding obtained in that time, there seems to be no good reason why he should not take his bottle in about the same time. If the nipple holes are of good size so that the milk flows freely, nearly all strong infants will finish the bottle in less than ten minutes. They evince less distress than the nurse does over the rapid feeding. On the other hand, a slow nipple either discourages the baby so that he will give up in disgust before he has

finished the bottle, or else makes him swallow so much air that he vomits or has colic. We believe that from eight to ten minutes should be ample time for any but the feeblest infants to take a bottle.

CONCLUSIONS

The method of fractional weighing may well be applied to every breast fed baby since it is the only way by which we can determine how long a given baby should nurse, and whether he needs one or both breasts.

It seems fair to conclude that a normal baby who gets enough milk from one breast needs to nurse, as a rule, only from six to eight minutes, rarely from ten to twelve minutes.

A baby who needs both breasts may nurse from six to eight minutes on the first and from five to seven on the second. Very few babies need as long as ten minutes on a breast. A good many will empty the breast in four or five minutes.

There is no evident reason why a baby should not take a bottle feeding as fast as he does one from a breast.

INTRAVENTRICULAR AND SUBDURAL SERUM TREATMENT OF MENINGOCOCCUS MENINGITIS IN INFANCY *

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The treatment of meningococcus or epidemic cerebrospinal meningitis in infants, especially in the hospital class of patients, has not been entirely satisfactory. The mortality rate and the incidence of sequels, even with careful serum treatment, are too high. The results obtained at the Infants' Hospital in a series of cases treated by lumbar puncture before the use of serum did not differ materially from a series treated later with serum. In other words, for some reason, serum has not proved so helpful in the treatment of hospital infants as has been expected. Why this should be so has been a subject for consideration with us for several years that we might find a reason and hence improve the treatment.

It seems to us that two factors are responsible for a high rate of mortality and sequels in infancy. The patients are seen late or are admitted to the hospital after the meningeal symptoms are well pronounced. This means that it is already too late to give treatment for the stage of general infection of the disease by use of intravenous serum. It follows that the infant's resistance to infection is lowered by the delay, and also the local meningeal resistance. More important than the late admission or rather delayed treatment is the failure of the serum, as usually given, to reach the focus of inflammation, which is essential, for the antimeningococcic serum must come in contact with the meningococci. It is too late to give serum into the veins after the process is local in the meninges, as the serum is not filtered through the secreting apparatus in the brain in such a form as to be of any advantage locally.

The reasons for failure of the serum to reach the desired regions will be apparent, if some of the peculiarities of the meningeal involvement in infancy be considered. These peculiarities show why it is not easy for serum as given into the lumbar spine to reach all the inflamed areas. It appears that the principal lesions in infants are at the base of the brain, a so-called basillar meningitis. In consequence, depending somewhat on the amount of the inflammatory products, the arachnoid spaces of the spine are more or less shut off from those above. Hence,

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there is always some interference with the flow of the cerebrospinal fluid from above downward into the spinal spaces, at times amounting to a complete blocking. Another interference with the flow of the fluid may occur by closuré of the foramina of Magendi and Luschka. These foramina are proportionally small in infants and are easily closed by adhesions or by products of inflammation. We have spoken of these peculiarities as interfering with the flow of the cerebrospinal fluid. It would seem natural to infer that whatever interfered with the flow of the fluid would also interfere with the dissemination of serum when introduced into the lumbar spine. Though the principal lesions are at the base of the brain, two other regions are involved which seem to us of great importance in infants and add much to the difficulty of the treatment. Inflammation of the ventricles appears early in the disease and naturally as the only approach to the ventricles is through the small foramina, there is little chance of serum given in the spine to come in contact with the organisms in the ventricles. The other region is the subdural space over the cortex. The fine adhesions found so commonly over the cortex of the brain of the normal infant favor the formation of pockets of inflammation, consequently serum introduced into the lumbar region cannot reach these cortical areas.

Another explanation has been offered for shutting off the foramina of Magendi and Luschka and also the spinal spaces from above. With increased tension in the ventricles the hemispheres are pressed against the skull and the exudate over the cortex is driven into the basal cisternae. This causes some interference with the absorption of the cerebrospinal fluid and with the circulation. These factors with the internal hydrocephalus, with the edema of the tissues, and especially with the distended posterior horns of the lateral ventricles cause the cerebellum to press against the medulla, hence shutting off the spinal spaces from above and partially closing the foramina. This is purely mechanical and may be entirely relieved as the case improves.

Taking these pathologic findings into consideration, it seems plausible that the difficulty in the treatment lies with the failure of the serum to reach the proper place. Even when fluid is obtained by lumbar puncture, we have reason to believe that serum introduced into the lumbar spine does not spread into the inflamed areas or go beyond the lowest level of inflammation and hence cannot do its work. Therefore, if the serum is to do its best work, it must be introduced above the block or partial block, flow over the inflamed areas, and, if possible, be drawn off by lumbar puncture.

Infants with open fontanels or cartilaginous fontanels offer easy approaches for giving serum from above. We began in 1914 to give serum for the treatment of meningitis into the lateral ventricles in cases in the wards at the Infants' Hospital. At first we hesitated to

go into the ventricles unless we were unable to obtain fluid by lumbar puncture or unless the case did not improve with spinal serum. Later we found that resistant cases had infected ventricular fluid and we were ready to act more boldly though there might be good lumbar drainage. Now we consider it proper to give early intraventricular serum, especially if the fluid withdrawn is turbid indicating a ventriculitis, which commonly occurs in the first few days of the meningeal stage, if indeed, the ventricles may not be the first location attacked. We believe that early introduction of serum into the ventricles will prevent partial or complete blocking of the spine, which led us in the first place to consider intraventricular serum necessary. If there is complete blocking of the spines high and there is a dry lumbar tap, it is all the more necessary to give serum high above the block. There may be no interference with the passage of the fluid out of the ventricles through the foramina and serum introduced into the ventricles can flow out, clear up the meningitis, and later fluid be obtained by lumbar puncture. If the foramina are closed, it may be with inflammatory products only in conjunction with a ventriculitis or by a sagging as mentioned above and serum given into the ventricles can clear the ventriculitis and hence the passages.

The results of intraventricular injection of serum have been encouraging. The technic is easy and with ordinary care there is no danger. Directions are given in textbooks, and in articles on hydrocephalus, for puncture of the lateral ventricles, but it is necessary to vary according to circumstances. The needle should be of good size, at least 6 cm. long, and we prefer it without a stylet. The most important direction to remember is never to move the needle in a lateral direction after it is introduced through the skin. If it is desired to change the direction of the needle, pull it out and start again in the new direction. Only in this way can injury to the brain substance be avoided, for the fulcrum of its level is at the tough skin and any lateral motion of the butt of the needle will be as great or greater at the point. The needle should be introduced through the anterior fontanel at one side of the median line, far enough from the middle to miss the longitudinal sinus, and in a line joining the lateral angles. The direction should be a little forward and toward the outer canthus of the eye on the same side. It is never necessary to go in more than 4 cm., but if the ventricle is dilated, the distance is less in proportion to the dilatation. We think it better not to puncture both lateral ventricles at the same time, unless the opposite ventricle is not emptied or unless there is very thick fluid withdrawn from the first ventricle. The following case will serve to illustrate the necessity for ventricular serum:

CASE 1.—J. A., 6 months old, was admitted June 22, after an illness of ten days. Spinal fluid was purulent, under pressure, with many gram-negative

intracellular and extracellular diplococci. Serum was injected intraspinally on successive days till June 25. Lumbar puncture, June 27: small amount of thick pus. July 2: dry lumbar tap. Fontanel bulging. Ventricular tap, fluid purulent, many organisms. With three intraventricular injections on alternate days the ventricular fluid cleared, and was free from organisms. Uneventful recovery. Last seen in June, 1921, and was in excellent condition.

There is an occasional case that persists in what might be called a chronic state. The patient is spastic, with slight fever or with normal temperature, is bright or lethargic. Organisms may be present in the spinal fluid but usually not; ventricular fluid negative; digestive symptoms of vomiting and poor appetite. Such cases resist serum given into the lumbar spine, and as the ventricular fluid is clear, they probably are resistant by reason of inflammation on the cortex not reached by the serum given.

In June, 1916, one of us (W. W. H.) injected serum in two such cases subdurally over the cortex at the outer angles of the fontanel. The first case showed a fall in temperature the day following the injection, and later a spinal fluid free from organisms. Unfortunately, the patient died a week later of bronchopneumonia. The postmortem showed the meningitis to have cleared.

The operation has been done many times since, and in some cases serum introduced subdurally has yielded marvelous results, and evidently reached a focus. The following case is mentioned to show the type of case and the results of treatment:

CASE 2.—E. B., 7 months old, was admitted May 7. Onset said to have been two months previous. Patient was thin, emaciated, mentality slightly cloudy, neck stiff, extremities spastic, reflexes increased, fontanel bulging. Lumbar puncture: cloudy fluid; 7,000 cells; 66 per cent. polymorphonuclears; gram-negative intracellular diplococci. With spinal serum by May 15, the spinal fluid was negative. Bulging of the fontanel was relieved by lumbar puncture. The baby still was spastic, losing weight and vomiting. It was thought to be a feeble baby with a chronic fat indigestion, but there was no relief with changes in food. The vomiting, stiff neck, rigid extremities and increased reflexes persisted. June 21, subdural injection of 10 c.c. of the same serum was made into the spine. The serum was given on both sides at the same operation. Marked improvement resulted in two days. Vomiting ceased. The spasticity gradually cleared.

The technic of subdural injection is very simple. A 10 c.c. Luer syringe with a 16 gage needle is filled with serum. The puncture is made at the outer edge of the fontanel, so that the needle slips obliquely under the bone, thus making it easy to go through the dura. When through the skin and dura and in the subdural space, the plunger of the syringe will move in without force. The operation should not be attempted with a bulging fontanel, for with a brain pressing hard against the skull the serum will not distribute well, and there is some danger of increasing the local pressure, hence causing cortical lesions. Excessive fluid is withdrawn by lumbar or ventricular puncture before

doing a subdural injection. If the ventricular fluid is cloudy and contains organisms, serum must be given into the ventricles as well as subdurally, for it is improbable that serum given subdurally will cure a ventriculitis.

During the years 1914-1920 there were treated in the wards of the Infants' Hospital eighty-one cases of epidemic cerebrospinal meningitis in infants under 2 years of age. Three of these infants were taken home against advice of the hospital, before sufficiently treated, and died within a few days. Seventy-eight received treatment as long as necessary in the hospital. Forty-two were treated by spinal serum injections alone, with a mortality of twenty-six cases, or 62 per cent. These were the ordinary favorable cases, and at the time no other treatment seemed necessary. The remaining thirty-six patients either did not improve with spinal serum, or, for other reasons found at examination, were not expected to improve, hence were given in addition to spinal serum injections, intraventricular or subdural injections, and sometimes both. There were nineteen deaths among the thirty-six, a mortality of 57.7 per cent. This indicates that we were able to get better results in the very ill than in the more favorable cases, by giving serum above the blocked or pocketed regions.

We were astonished, in following the cases to June, 1921, that many patients discharged "well" from the hospital developed hydrocephalus, deafness, blindness or some sad result. There appears to be, so far as we know, no way to determine if an infant is cured and in no danger of sequels, even if the spinal fluid becomes normal.

Thirty-three of the seventy-eight subjects were discharged from the hospital living and with negative spinal fluids, but eight of them died in from a few days to two years after discharge. Of these eight, three had spinal treatment only, five intraventricular as well as spinal treatment. One of the three spinal patients died of a relapse, one of empyema following measles, one a year and a half later of a complication following otitis media. Four of the five patients with intraventricular involvement died of bronchopneumonia several months after leaving the hospital and two of these showed normal brains at necropsy; the fifth returned to the hospital as a feeble feeding case with hydrocephalus, and obstructive hydrocephalus was found at the necropsy.

In June, 1921, we were able to account for the remaining twenty-five cases of the series. Fourteen patients are living and well; eleven are living but have serious sequels. The fourteen "well" cases are equally divided as to type of treatment, seven having received spinal injections and seven high injections of serum. This is a highly satisfactory result, for the ventricular and subdural cases were more discouraging at the start. However, the eleven cases with sequels tend to indicate the value of high injections in that six were spinal cases, supposed to be favorable at the start, and five were given high injections.

We have yet to see any harm done by careful intraventricular or subdural injection of serum, as shown clinically or by necropsy findings. Though the number of cases in this series may be rather small on which to base hard and fast conclusions, yet we are convinced from the study of these cases that the spinal introduction of serum is not sufficient, and in order to better the results, serum should be introduced into the ventricles early in the disease and repeated so long as the ventricular fluid is cloudy, or drainage from the lumbar spine is poor. The subdural injection of serum is indicated, when there is evidence of cortical irritation. Though it may seem radical, we believe that by the early high injection of serum, it would be possible in many cases to clean up areas of inflammation, which later cause mechanical and degenerative sequels.

THE INCIDENCE OF THYMIC ENLARGEMENT WITHOUT SYMPTOMS IN INFANTS AND CHILDREN *

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This report consists of an analysis of two thousand consecutive cases admitted to the University of Michigan Hospital during a period of nearly two years. The ages of these patients range from 3 days to 12 years. All infants and children coming to the hospital are first admitted to the pediatric clinic for examination, so that both surgical and medical cases are included in this group. Of the two thousand patients there were only three who came because of symptoms related to the thymus gland. A large number of patients with thymic symptoms were observed during this time, but are not considered in this report, as they were treated in the outpatient department and not admitted to the wards. The patients studied were those in whom there was no particular reason to suspect thymic enlargement from the history. The diagnosis rests on physical examination, roentgen-ray examination of the thorax, and in some instances postmortem examination.

A report of a special group of these patients, those with harelip and cleft palate, has already been published [1] in which the question of thymic enlargement in relation to operative procedures is briefly considered. Blackfan and Little,[2] in a study of sixty infants, found evidence of thymic enlargement in twenty-nine, or 48 per cent These infants were unselected cases and there was no reason to believe that the thymus gland was enlarged. In other words, they were so-called "normal infants" as far as thymic symptoms were concerned. They base their belief that the shadow found in roentgen-ray examination of these infants was due to an enlargement of the thymus on the following grounds: (1) The shadow disappeared after exposure to the roentgen ray. (2) It could not be distinguished from the shadow which at necropsy was proven to be cast by the thymus. (3) It is identical with that found in patients with clinical evidence of an enlargement of the thymus.

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1. Greenthal and Lyons: Dental Cosmos **14**:186 (April) 1922.
2. Blackfan and Little: Am. J. Dis. Child. **22**:[illegible] (Nov.) 1921.

Blackfan and Little further state: "Whether this shadow should be interpreted as an enlarged thymus or whether it should be regarded as occurring normally in a certain percentage of normal infants cannot be stated at the present time." This report endeavors to show what happens to some of these "normal" patients with enlarged thymic glands during a period of unusual stress, such as surgical procedures and illnesses. It leads us to the belief that the finding of an enlarged thymic gland, even though there has been no clinical evidence of thymic symptoms, should not be regarded lightly. We have endeavored to check as far as possible the accuracy of the clinical and roentgenologic diagnosis of thymic hypertrophy, also to ascertain if the preoperative treatment of these patients is of any value in preventing "thymic" deaths, and to find out in what type of patient an enlarged thymus is most likely to be found.

In a discussion of the thymus, it is customary for most writers to state that at the present time the cause of so-called thymic death is not known. Some have even doubted whether the thymus per se is involved at all. However, the occurrence of an enlarged thymus, that is, a thymus gland which weighs more than the average, is frequently associated with the well known status thymolymphaticus and affords the best means of clinically recognizing this diathesis. It is also true that procedures which cause atrophy or fibrosis of this gland, such as radium and the roentgen ray, usually relieve thymic symptoms. We further believe that these same procedures may prevent the catastrophes which often affect persons with a thymolymphatic constitution. Argument for this belief will be discussed later.

In this series of two thousand cases a diagnosis of enlargement of the thymus was made clinically in ninety cases. This is an incidence of 4.5 per cent. The diagnosis was confirmed or made by means of the roentgen ray in each instance. A roentgenogram of the thorax was taken for various reasons in 351 patients of this series. The percentage of positive thymus cases among those in which roentgen-ray examination was made is, therefore, 25.6 per cent. The total incidence of enlargement of the thymus in these two thousand cases is, of course, too low. Had a roentgenogram been obtained for each patient, we would have found many more with enlarged thymic shadows. Yet Blackfan and Little found 48 per cent. of their sixty infants to have an enlargement of the thymus. We believe that the difference in our figures can be explained by the ages of the patients. In their series forty-five were under 4 months of age, and thirty-five were less than 2 weeks old. In our series the great majority of patients were more than 6 months old and some were as old as 12 years. Bovaird and Nicoll [3] have shown that

3. Bovaird and Nicoll: Arch. Pediat. **23**:641, 1906.

the weight of the thymus is greatest at birth. Physiologically it diminishes about twenty per cent. during the first five years and further diminishes after this time.

In the accompanying table a list of the various conditions is given in which enlargement of the thymus was found. One is struck by the fact that many of the cases are associated with congenital defects and malformations. Of the ninety patients who showed enlargement of the thymus, forty-four, or 49 per cent., came to the hospital for the treatment of congenital malformations or defects. If we consider only the 351 patients of whom a roentgenogram of the thorax was taken, the total incidence of enlargement of the thymus is 25.6 per cent.

SHOWING THE VARIOUS CONDITIONS IN WHICH AN ENLARGED THYMUS WAS FOUND

Disease	No. of Cases	Disease	No. of Cases
Rickets	3	Congenital elevation of scapula	1
Harelip and cleft palate	24	Congenital hydrocephalus	1
Tuberculosis of spine	1	Sarcoma of the orbit	1
Congenital club feet	4	Hemangioma	3
Congenital malformation of extremities	3	Foreign body in esophagus	1
Phimosis	2	Achondroplasia	1
Tonsils and adenoids	14	Hereditary syphilis	2
Feeding regulation	2	Empyema	1
Thymic asthma	3	Phlyctenular conjunctivitis	1
Fracture of nose	1	Foreign body in bronchi	2
Congenital goiter	1	Spastic paraplegia	1
Imbecility	2	Cretinism	1
Pneumonia	4	Congenital dislocation of hips	3
Corneal ulcer	1	Hypospadias	1
Mastoiditis	1	Lymphatic leukemia	1

The frequency of enlarged thymus in infants and children with congenital defects is also shown by the following facts: In this series a roentgen-ray examination of the thorax was made in sixty-three patients with harelip and cleft palate. Twenty-four, or 38 per cent., showed thymic enlargement. In ten patients with spina bifida and club feet, seven, or 70 per cent., showed a shadow which was considered too broad. One hundred and ten patients coming for tonsil and adenoid operations had roentgenograms of the thorax. Of these only fourteen, or 13 per cent., showed enlargement of the thymus gland. It would seem, therefore, that congenital malformations and defects are frequently associated with thymic enlargement. This fact has been impressed on us so often that in the pediatric clinic we now have a

roentgenogram of the thorax made of every infant and child with congenital malformations and defects and examined carefully for thymic enlargement.

A consideration that was of great interest to us in this analysis was the reliability of the physical examination and roentgen-ray diagnosis of thymic enlargement. In a patient who has never had thymic symptoms and who has not the appearance of a thymolymphatic status, the finding of an enlarged thymus may lead one to the belief that the shadow cast on the sensitized plate and the increased percussion dullness are due to other structures, such as the great vessels or glands. However, we found that the diagnosis was correct in the great majority of cases. The criteria of Blackfan and Little hold good in our series. We found that roentgen-ray treatment reduced the shadow. The shadow was exactly the same as that found in patients with clinical evidence of thymic enlargement. In this series seven patients showed no evidence of an enlarged thymus on physical or roentgen-ray examination. The necropsy confirmed this finding in each instance. In five patients thymic enlargement was discovered. The necropsy showed not only a hyperplastic thymus but the other findings of status thymolymphaticus. One patient in this series presented the physical findings of thymic enlargement and gave a characteristic history of thymic asthma. There was also a congenital heart lesion. This patient later developed bronchopneumonia and was admitted to the hospital. The roentgenogram of the thorax was entirely negative. Nevertheless, the patient received one treatment for the enlargement of the thymic gland as recognized by our examination. The necropsy, made one day later, showed a bronchopneumonia, congenital stenosis of the aortic isthmus, a hyperplastic thymus with some atrophy due to the treatment, and the other findings of status thymolymphaticus. For some unaccountable reason the roentgen ray failed to show either the enlarged thymus or the bronchopneumonia. Except for this one instance, necropsy has confirmed the roentgen diagnosis in every case in which it has been permitted.

The nutritional status of infants and children with thymic enlargement has also been a point of interest. It has been a popular conception that thymic enlargement occurred chiefly in well nourished persons. Our findings have for some time led us to believe that such is not the case, in which respect we again confirm the observations of Blackfan and Little. We have frequently found an enlarged thymus in poorly nourished and marantic patients and just as frequently have we found no thymic enlargement in well nourished infants and children. The nutritional status and bodily conformation have by no means given us the suggestion of lymphatism in a large percentage of the cases here recorded. It has suggested this state in a few instances.

We have necropsy reports on six patients observed during the time of this study, whose death may have been related to enlargement of the thymus gland or to status thymolymphaticus.

ABSTRACT OF CASES

CASE 1 (5381).—A boy, aged 12, was admitted to the hospital because of convulsions, defective vision, and a speech defect. The clinical diagnosis was epilepsy and motor aphasia with the possibility of a localized lesion in the brain. An exploratory decompression was performed but nothing abnormal was found. The patient died six hours after the operation. The necropsy report was: Status lymphaticus; lipoidosis of the suprarenals; persistent hyperplastic thymus. A roentgenogram of the thorax was not taken in this case.

CASE 2 (5376).—A poorly nourished baby, aged 6 weeks, was admitted to the hospital because of bronchopneumonia. Thymic asthma and a congenital heart lesion had previously been diagnosed. The roentgenogram of the thorax was negative for all conditions. The patient received one therapeutic roentgen-ray treatment the day before death. The necropsy report was: Thymico-lymphatic constitution; hyperplastic thymus with roentgen-ray atrophy; acute bronchopneumonia; congenital stenosis of the isthmus of the aorta.

CASE 3 (5762).—A malnourished infant, aged 5 months, was admitted to the hospital because of hydrocephalus. The infant also showed signs of rickets. The report of the bacteriologic examination of the cerebrospinal fluid was a meningococcic infection. Following the second injection of serum into the ventricles, the temperature rose quickly to 107 F. and death occurred a few hours later. The findings at the necropsy were: Internal hydrocephalus; papilloma of the choroid plexus; status thymolymphaticus; hyperplasia of the suprarenals; rickets. A roentgenogram of the thorax was not taken.

CASE 4 (6241).—A boy, aged 3 years, was admitted to the hospital for removal of tonsils and adenoids. He also had achondroplasia. A roentgen-ogram of the thorax was taken in order to show the bony structures. No mention of the thymus gland was made in the report. The child died immediately after the operation. The necropsy report was: Marked thymic hyperplasia; thymicolymphatic constitution; hypoplasia of the suprarenals; achondroplasia. At our request the plate was re-examined several months later and a very definite shadow of an enlarged thymus gland was found

CASE 5 (6451).—A marantic infant was admitted to the hospital for severe diarrhea with toxic symptoms. After a stormy course during which time many infusions were given, the infant recovered and began to do very well at home. The baby was readmitted to the hospital at the age of seven months because of otitis media and pyuria. The patient was much improved four days later and had a normal temperature. Death occurred suddenly that day. The pathologist reported: Otitis media; lymphatic constitution; suprarenal hypoplasia with lipoidosis; hyperplasia of the thymus, especially of the medullary portion.

CASE 6.—A fairly well nourished infant, aged 3 months, was admitted to the hospital for the repair of a harelip and cleft palate. The roentgenogram of the thorax showed an enlarged thymus. The patient received two pre-operative treatments at weekly intervals and then was operated on successfully. The convalescence was rapid and uneventful. Two months later the patient was scheduled for the second operation. He was found dead in bed the night before he was to be operated on. At necropsy the following diagnosis was made: Thymico-lymphatic constitution; hyperplastic thymus (cortex only); lymphoid hyperplasia; suprarenal hypoplasia; cardiac dilatation; pulmonary congestion.

Does the preoperative roentgen-ray treatment of patients who have enlargement of the thymus gland lower the number of operative deaths?

We believe that it does, although it is very difficult to prove this point definitely. In this series of cases there was no immediate death following operative procedures in patients treated before operation. There also were no sudden deaths in the patients who did not show enlargement of the thymus. It seems more than a coincidence that the patients who died suddenly after operative procedures all showed a thymolymphatic constitution and none of them had been treated. Yet these facts do not justify a dogmatic statement that the mortality rate has been lowered because we have treated the patients before operation. We do not know what would have happened had these patients received no treatment. Statistics, too, are unreliable. It has been our impression, and that of others in the hospital, that the immediate mortality rate following operation in infants and children has been lowered, but there are so many other factors which may play a part, such as better technic and anesthesia, better preoperative care, different types of cases, etc., that we cannot be sure.

It is quite certain that all patients with enlargement of the thymus do not die when operated on. A little boy whose general appearance and physical examination suggested thymic hyperplasia came into the hospital for circumcision. A roentgenogram of the thorax was ordered to confirm our diagnosis. Through a misunderstanding the patient was operated on before the picture was taken. The operation and his convalescence were uneventful. The roentgenogram was then taken and disclosed an enlarged thymus for which he was treated. A little girl, aged 2 years, with a long standing pyuria was admitted for cystoscopy. There was nothing in her history to suggest thymic enlargement. While under the anesthetic she had a convulsive seizure. A roentgenogram of the thorax disclosed an enormous thymic shadow for which she was treated. Gerstley [4] reported an interesting case, that of a little boy who was known to have thymic enlargement. He needed a tonsil operation very badly. This was done and no untoward results occurred.

On the other hand, it seems reasonable to give these patients the benefit of a treatment which we know will reduce the size of the thymus gland. We are aware of the marked reduction in size of the thymus that can be secured when patients with thymic symptoms are exposed to therapeutic roentgen rays or to radium emanations. We know of no reports of harmful effects following this form of treatment of the thymus and we have never observed any in this clinic. Because some patients with thymic hyperplasia go through operations or severe illnesses without trouble, does not mean that all will do so. We have no means of knowing beforehand who will be the fortunate ones. It

4. Gerstley: M. Clinics N. America **5**:245 (July) 1921.

would seem, therefore, that the reduction of an enlarged thymus is indicated in all patients before operation.

How shall we treat nonoperative cases which show thymic enlargement? We have given all these patients roentgen-ray treatments in order to reduce the size of the gland. It is our belief that this, too, is a beneficial procedure. It has long been known that some patients with enlargement of the thymus react to illnesses in a violent manner. For example, an infant aged 9 months contracted pneumonia. The temperature quickly rose to 106 F. and death occurred in two days. The necropsy showed a large hyperplastic thymus, status thymolymphaticus, an extensive pneumonia with beginning empyema on the right side. A malnourished infant contracted pertussis and later lobular pneumonia. At the end of the second week the temperature rose to 106 F. and the infant had a series of convulsions with temporary cessation of respiration each time. The infant finally recovered, except for a marked stridor and rapid respirations. A roentgenogram taken at this time showed thymic enlargement. After the gland had been reduced in size the stridor disappeared and the respirations became normal.

What happens to these patients with thymic enlargement and no symptoms if they are left untreated? In many instances the gland undergoes a gradual physiologic atrophy and nothing happens. In other cases, the thymus enlargement persists into adult life and may then cause symptoms. "Thymic" deaths have been observed in adult patients at this hospital since we have been paying particular attention to this subject. During the influenza epidemic of 1918, we cared for soldiers in our wards. Many of the fatal cases showed a persistent hyperplastic thymus at autopsy.

It would seem advisable to watch persons in whom thymic hypertrophy is detected. If they develop symptoms they should be treated at once. If one does not think it advisable to reduce the size of the gland, frequent examinations should be made to determine whether the thymus is undergoing the normal gradual atrophy. If it is not, it should be treated.

CONCLUSIONS

1. In a series of two thousand consecutive hospital admissions, thymic enlargement was diagnosed in ninety, or 4.5 per cent. Of these ninety patients, eighty-seven gave no history or presented no symptoms of thymic involvement.

2. Enlargement of the thymus was noted in 25.6 per cent. of all the patients who had a roentgenogram of the thorax made.

3. Patients with congenital defects and malformations are more apt to have thymic enlargement than are other patients.

4. It is possible that the mortality rate of operated cases was lowered by preoperative thymic treatment.

5. It would seem advisable to give thymic treatment to persons with thymic enlargement, even though they have no clinical evidence of thymic hyperplasia.

CLASSIFICATION AND MANAGEMENT OF ASTHMA IN CHILDHOOD*

THE IMPORTANCE OF RABBIT HAIR AS A CAUSE IN NEW YORK CITY

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It was deemed worth while to publish a report of the first one hundred cases seen in the Children's Asthma Class at Bellevue Hospital on account of the unusually high percentage of positive reactions to animal emanations. The report also emphasizes the necessity of separating true asthma from chronic pulmonary infections in children.

The consideration of asthma and allied conditions has been reviewed so often and so thoroughly of late that no attempt will be made to summarize the literature on the subject.

Diagnosis.—The classification of the cases into either sensitive or nonsensitive was not usually made until the patients had been under observation for some time. The patients were given the telephone number of one of the attending physicians and urged to call him at the onset of an attack. Whenever possible, a visit was made at once and, though this was not practical in every case, an effort was made to study the type of the attack and only thereafter was a definite diagnosis made.

The cases seen were placed in one of two groups according to the following clinical findings:

SENSITIVE TYPE	NONSENSITIVE TYPE
1. COURSE OF THE DISEASE	
Periodic attacks with complete or nearly complete cessation of pathologic signs between the attacks.	Either chronic cough without dyspnea or periodic remissions with moderate dyspnea but the pathologic signs tended to remain constant between the remissions.
2. TYPE OF THE ATTACK	
Onset in which dyspnea was the most prominent symptom. This was usually characterized by slow, labored breathing with prolongation of the expiratory phase up to the beginning of the inspiratory phase so that there was no period of rest between. Cough was not prominent at first but later, after the dyspnea had begun to subside, it became more prominent and	In those with periodic remission cough at the onset was the most prominent symptom. Dyspnea, if it appeared came on from twenty-four to forty-eight hours later and was not as severe as in the sensitive type. It also had a tendency to be more inspiratory in type. On auscultation during the attack the râles were often very similar to those found in the sensitive

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* From the Children's Medical Division of Bellevue Hospital.

SENSITIVE TYPE	NONSENSITIVE TYPE
2. TYPE OF THE ATTACK—(*Continued*)	
lasted after the dyspnea had entirely disappeared. On auscultation in the early stages the râles were similar in all parts of the chest and occurred about equally during all parts of both inspiration and expiration. Toward the end they became looser and were patchy in their distribution, resembling those of simple bronchitis. There was usually acceleration of the pulse rate but no rise in temperature.	type and later also showed a loose quality, but between the attacks these showed a tendency to remain constant though fewer in number. There was nearly always acceleration of the pulse rate accompanied by a rise in temperature.
3. DURATION OF THE ATTACK	
This varied from a few minutes to a few days and was followed by a relatively rapid convalescence.	This varied from a few days to a week or more and convalescence was relatively slower.
4. QUALITY OF THE SPUTUM	
When obtained this showed a fairly clear gelatinous material with small opaque bodies, Laennec's pearls.	This was slightly more profuse, was thick, yellow or greenish, and purulent.
5. BEHAVIOR TO EPINEPHRIN	
Intramuscular injections of a solution of epinephrin chlorid, 1:1,000 gave marked immediate temporary relief.	The relief obtained was not as marked.

The two types are often extremely hard to differentiate as, after repeated frequent attacks, the sensitive type may have many signs of a subsequent bronchitis which, however, finally clears up when the attacks cease. Roentgen-ray examinations were made of every case as a routine as well as total and differential white blood cell counts. The differential cell count in the sputum showed a high percentage of eosinophils in both types. These criteria were found of only occasional value in making the diagnosis. It is perhaps well not to draw a hard and fast line between the two. It is only by taking all factors into consideration that the impression is gathered that the child adheres more to one group than the other. No one factor is sufficient to make the diagnosis and all factors are not found in every case.

It is interesting to note that in the sensitive group the average age of onset was 3.7 years, the earliest case occurring at birth and the oldest child being 9 years of age. The average duration was 5.92 years. In the nonsensitive group the average age of onset was 3.42 years, the youngest patient being aged 3 months and the oldest 11 years. The average duration was 4.02 years.

Skin reactions to proteins were performed at the clinic and using these in conjunction with the clinical findings the cases were classified as follows:

Group I, sensitivity determined, 44 cases; group II, sensitive type but reactions negative, 12; group III, chronic bronchitis, 33; group IV, not sufficiently tested to classify, 11. Total 100 cases.

GROUP I.—*Sensitivity determined.*—Of the forty-four cases in which sensitivity was determined, thirty-one, or 70 per cent., gave positive skin reactions to one protein, and thirteen, or 30 per cent., gave reactions to more than one protein. The number of reactions tried on each patient varied from seven to forty-five. When there was a definite history of contact with a certain protein followed by symptoms and when a definite skin reaction to that protein was obtained, it was not considered necessary to try further tests.

In this group the reacting proteins were:

Rabbit hair, 32 positive reactions; horse dander, 8; cat hair, 6; dog hair, 1; guinea-pig, 1; feathers, 1; foods, 8; pollens, 3; total, 60 positive reactions.

Of sixty positive reactions obtained, thirty-two, or 53 per cent., were from cases which showed sensitivity to rabbit hair. Walker,[1] on the other hand, said, "Of the animals, the horse is the chief cause and the cat is a frequent cause; other animals play a minor rôle." The possible significance of this will be discussed later.

The skin reactions were performed by the standard scratch method and read at the end of twenty minutes. No one of the reactions included was less than two plus and the majority were four plus.[2] Wherever possible, every positive reaction was checked by an intracutaneous test, using solutions supplied by Dr. Coca. The two methods cannot be compared directly as shown in a previous paper.[3] In the present series the sensitivity as determined by the two methods agreed in twenty-nine persons. In several instances one sample of a dry commercial preparation would give a negative reaction, whereas another sample from the same commercial house would give a definitely positive reaction. These preparations were tested repeatedly on sensitive subjects. Some of the powders which failed to react were from fresh lots. It was, therefore, not a question of age or dampness. In one instance, three different samples failed to react, whereas a fourth preparation gave a definite reaction. There was no apparent difference in these preparations in gross appearance or solubility and the positive reaction was obtained with a powder bought four months before two of the others which gave no reactions.

Pseudoreactions were not uncommon with both methods. These reactions were moderate in size, definitely larger than the controls and sometimes showed pseudopods. Repeated skin tests on different days

1. Walker, I. C.: The Cause and Treatment of Bronchial Asthma, M. Clin. N. America **1**:1177 (Jan.) 1918.

2. In the cutaneous method one plus was used to indicate a reaction in which the wheal measured from 0.5 to 1.0 cm.; two plus, from 1.0 to 1.5 cm.; three plus from 1.5 to 2.0 cm., and four plus, above 2.0 cm.

3. Larsen, N. P., Alexander, H., and Paddock, R.: Bronchial Asthma and Allied Conditions, J. Immunol. **7**:81 (March) 1922.

proved them to be negative. This type of reaction may well account for some of the results obtained on normal children by Baker [4] and by Peshkin and Rost.[5]

Several cases showed positive skin reactions to proteins which had no relation to the production of symptoms. This has also been reported by Walker, Caulfeild and others. On the other hand, in two cases of food sensitivity, attacks regularly followed the ingestion of certain foods, but all skin tests remained negative.

These variations emphasize the fact that the skin reaction is merely one factor in making the diagnosis. Whether positive or negative, the skin test must not be allowed to outweigh all other contradictory evidence.

In all these cases an attempt was made to trace possible contact with the reacting protein, either in the home or in the environment. In thirty-two cases, or 73 per cent., the source of the protein was found. In rabbit hair cases the source was found in pillows, mattresses, comforters, collars on coats, hats, muffs, playthings, chest protectors, rabbits as pets, and unskinned rabbits brought into the home for food. In some homes the amount of rabbit hair was really astonishing. One father brought to the clinic nine samples from different pillows and mattresses in his home, all of which contained either pure rabbit hair or a mixture of rabbit hair with feathers or cotton. With one girl the attacks of asthma were definitely identified with the wearing of a hat which had been bought as a "beaver" hat. When bits of hair from this hat were teased out and put under the microscope they were found to be of two different types; the long silky hairs on the surface were from some animal other than a rabbit and very closely resembled cat hairs, but deeper, in the more densely matted or felt part of the hat, the material was undoubtedly rabbit hair. Eight cases of this type of asthma have been described by Ratner,[6] one of which was also caused by a felt hat.

The method of identifying epidermals is worthy of note. The microscope is invaluable and it is well to have on hand samples of known epidermals for comparison. A small amount of the unknown material is placed on a slide and a drop of 70 per cent. alcohol allowed to fall on it. This flattens the material and when the alcohol has almost evaporated another drop of a weak solution of alakali is added and a cover slip placed on this. More permanent slides must be

4. Baker, H. M.: Incidence of Protein Sensitization in the Normal Child, Am. J. Dis. Child. **19**:114 (Feb.) 1920.

5. Peshkin, M. M., and Rost, W. L.: The Incidence of Protein Sensitization in the Normal Child, Am. J. Dis. Child. **23**:51 (Jan.) 1922.

6. Ratner, B.: Rabbit Hair Asthma in Children, M. Clinics N. America **5**:1129 (Jan.) 1922.

imbedded in glycerin or balsam. On such a slide rabbit hair has a characteristic appearance. In the finer or down hairs the cells are in single layers and when the sides of these are examined the margins of the cells are seen to overlap, giving an imbricated or shingle-like appearance. These form tiny barbs along the hairs and though this is true to a certain extent of all hairs, the barbs are rather more prominent in rabbit hair. It is the interlocking of these barbs that gives the strength and firmness to commercial felt.

Treatment.—The most rational method of treatment, as shown by Cooke and others, is to remove the offending protein from the environment of the sufferer. The result is usually very striking. Complete desensitization as produced by Schloss [7] in a food case is apparently not readily obtained in persons sensitive to inhaled proteins. This has been repeatedly shown in pollen cases. These must be reinjected each year. Walker [8] published a series of twelve animal hair cases treated with gradually increasing doses of the offending protein with very good results. He concludes, "Patients whose asthma is due to the protein of horse dander and cat hair are relieved of asthma by subcutaneous injections of these proteins. The more thorough the treatment the more permanent the relief." Longcope [9] reports a case of chicken feather sensitivity in which asthma had existed for nineteen and a half years. After twenty-one injections, the highest being 0.5 c.c. of a 1:500 solution of the protein, the patient remained well. The removal of the feathers was not mentioned.

In the present series an attempt was made to remove the offending protein from the home in every case. Injections of a solution of rabbit hair protein, however, were also given to twenty children who were sensitive to this protein. This was done for several reasons. First, it at least produces an increased tolerance toward the offending protein, if not complete desensitization. Secondly, the repeated injections give an opportunity to teach the patient how to control his asthma. Just as a tubercular patient is taught how to care for himself, so an asthmatic must be taught to watch carefully for possible harmful protein contact. This is only accomplished after repeated visits. Thirdly, it helps to keep the case under continued observation. Lastly, the psychic effect that something definite is being done undoubtedly gives the subjects a happier point of view and a better chance to live a more normal life.

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7. Schloss, O. M.: A Case of Allergy to Common Foods, Am. J. Dis. Child. **3**:341 (June) 1912.

8. Walker, I. C.: Treatment of Patients with Bronchial Asthma with Subcutaneous Injections of the Proteins to which they are Sensitive, J. M. Research **36**:423 (July) 1917.

9. Longcope, W. T.: Protein Hypersensitiveness and its Importance in the Etiology of Disease, J. A. M. A. **77**:1535 (Nov. 12) 1921.

Just what rôle the injections had in the results obtained is hard to determine. Most of the patients were started with 3 minims of a 1:100,000 solution and carried through several injections of a 1:500 solution. The injections were increased from 1 to 3 minims per week. Of the twenty children who received injections, one child failed to show any improvement and three showed only slight improvement. In two cases in which no rabbit hair was found in the home, attacks ceased after the first injection. To date, a period of nine months, there have been no further attacks. Prior to this attacks had been almost constant, in one of the cases for three years, in the other for four years. In twelve cases in which the protein was located and removed immediate relief followed. These patients, however, were also given injections. Two other patients who came irregularly to the clinic showed about 50 per cent. improvement.

All the injected subjects were tested repeatedly to note the effect on the skin reaction. Individual skins, or perhaps individual sites on the skin, showed considerable variation in the size of of the reaction at various times. There was, however, no constant decline. At the end of the series in no case was there a change in the size of the skin reaction as far as the diagnostic test was concerned. No attempt was made to see if the reaction had changed as regards dilute solutions. Walker [10] showed a great decrease in the reaction to the dilute solutions in his pollen series and [8] a disappearance in some of his dander cases, after a series of injections.

One of the patients who was sensitive to timothy had been well for three seasons in a timothy district and for eight years previous to this time had suffered from typical early hay-fever. Nevertheless, he gave a markedly positive skin reaction to timothy. The relation between the size of the skin reaction and symptoms is still open to question.

GROUP II.—In this group were placed twelve cases in which all evidence pointed to a definite protein sensitivity. All skin tests were repeatedly negative.

GROUP III.—*Chronic Bronchitis.*—Of the thirty-three cases in this group none showed positive skin reactions.

Treatment.—For the first year at the clinic it was decided to find out what this group would do under general care. This consisted in:

1. Removal or treatment of any points of focal infection that could be found along the respiratory tract.

2. Home hygiene or country visits for as long as possible.

3. Rest.

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10. Walker, I. C.: Frequent Causes and the Treatment of Seasonal Hay-Fever, Arch. Int. Med. **28**:71 (July) 1921.

4. Open air classes in school, the diet being also increased by additional food.

5. Cod liver oil preparations.

At the end of this year it is felt that eighteen of the thirty-three patients show enough improvement to warrant their being classed as distinctly improved, as against fifteen whose condition has remained unchanged. Of those improved, ten have shown an absolute cessation of all attacks and pathologic signs, while eight seem to be improved but still show some attacks and pathologic physical signs.

As the quality of improvement is an extremely difficult factor on which to base conclusions, great care has been used in making this summary and the feeling is held that if any error has been made it is on the side of conservatism. A substantial proportion of this group would seem to yield to simple hygienic measures without specific treatment. It would be well to keep this proportion in mind in drawing conclusions from cases treated with vaccines.

GROUP IV.—In this group were placed cases which might belond to either Groups I, II or III, but due to insufficient observation it was not possible to classify them. Eleven cases were placed in this group.

DISCUSSION

A comparison of this series with some of the others already published is shown in the accompanying table.

COMPARISON OF CASES REPORTED BY VARIOUS OBSERVERS

Author	Number in Series	Number Giving Positive Reaction to Protein	Per Cent. of the Number in Series	Number Positive to Animal Emanations	Per Cent. of the Number Giving Positive Reaction to Protein	Number Positive to Rabbit Hair	Per Cent. of the Number Positive to Animal Emanations
Cooke [11]	327	240	73.4	138	57.5	18	13.0
Rackemann [12]	150	74	49.3	37	50.0	..	....
Rackemann [13]	301	194	64.1	55	28.3	..	....
Scheppegrel [14]	1,000	...	....	7	0.7	..	....
Walker [8]	...	40	....	12	30.0	..	....
Walker [15]	400	191	47.75	78	40.8	..	....
Walker [15] (cases below 15)	136	94	69.1	51	54.3	..	....
Present series	100	44	44.0	36	81.8	32	88.8

11. Cooke, R. A.: Studies in Specific Hypersensitiveness, J. Immunol. **7**: 147 (March) 1922.
12. Rackemann, F. M.: A Clinical Study of One Hundred and Fifty Cases of Bronchial Asthma, Arch. Int. Med. **22**: 517 (Oct.) 1918.
13. Rackemann, F. M.: A Clinical Classification of Asthma based upon a Review of Six Hundred and Forty-Eight Cases, Am. J. M. Sc. **162**: 802 (Dec.) 1921.
14. Scheppegrel, W.: Asthma and Hay-Fever, Philadelphia, Lea & Febeiger, 1921.
15. Walker, I. C.: A Clinical Study of Four Hundred Patients with Bronchial Asthma, Boston M. & S. J. **179**: 288 (Aug. 29) 1918.

These different series include subjects exposed to different environments. Those in the present series, living in crowded quarters on the lower East Side of New York City, were, as has been shown,

exposed to large quantities of rabbit hair. The cases (from New Orleans) in Scheppegrel's series [14] were undoubtedly exposed to greater concentrations of pollens. The environments of the others are not known but were, no doubt, different from the lower East Side of New York City.

Cooke and Vander Veer,[16] in reviewing their series of cases, remarked, "The mere fact that over 42 per cent. of a large number of sensitization cases are clinically multiple in type suggests very strongly the fact that such individuals as a group, possess a very peculiar capacity to become sensitive in a natural way, to certain proteins to which their environment and habits of life frequently expose them, and reasoning from analogy then we might expect that any form of foreign protein parenterally introduced would readily render them acutely sensitive." In one series of nonsensitive subjects and another series of sensitive subjects they compared the effect of the introduction of foreign serum. The two groups, however, showed practically no difference. They conclude that, "evidently the type of clinical sensitization that they (patients) acquire and maintain is dependent upon some other factor than the mere parenteral injection of native heterologous protein."

Although the present series is too small to warrant any definite conclusions yet added to the evidence that a very high percentage of patients react to a number of proteins, it certainly suggests the possibility that the type of protein in the environment may have some relation to the subsequent sensitivity. One can hardly exclude this evidence because of the fact that one series of cases which received one or two small subcutaneous injections of serum failed to show increased symptoms following their injections. Perhaps, it is necessary that the protein be in the environment during a long period of time or at a certain time in the individual's life, as for instance, during the course of whooping cough or other severe respiratory infections. It is well known that a certain number of patients date the onset from a period immediately following an acute respiratory infection.[1] Referring to ingested proteins, Talbot [17] says, "Injury to the mucous membrane is probably necessary, except shortly after birth, before the foreign protein can be absorbed unchanged. The greater the injury to the intestinal mucous membrane the more easily can foreign protein pass through the intestinal wall. The younger the infant is the more easily can a foreign protein pass through the healthy, uninjured, mucous membrane." This may be also true of the mucous membrane

16. Cooke, R. A., and Vander Veer, A. Jr.: Human Sensitization, J. Immunol. **1**:201 (June) 1916.

17. Talbot, F. B.: Asthma in Children. Its Relation to "Egg Poisoning" (Anaphylaxis), Boston M. & S. J. **171**:708 (Nov.) 1914.

of the respiratory tract. An observation which seems to contradict this, however, is the following: A medical student known to be definitely sensitive to lobster and ragweed worked for a drug concern. One of his duties consisted in grinding urease into a very fine powder. He did this for a few days at a time every two or three weeks. He worked from April until July without symptoms. In July, as he poured the fine powder into a container, he had symptoms for the first time. These consisted in sneezing, coughing and burning of the eyes. A skin test was tried and gave a positive reaction to urease. From then on, each time he was exposed to the powder he suffered from the same symptoms. Unfortunately, no skin test had been tried with this substance prior to the onset of symptoms.

More evidence is necessary before definite conclusions should be attempted. At present, however, it seems probable that the concentration of a protein in the environment of a child with a tendency to develop sensitivity has something to do in determining what specific protein or proteins will later affect him. This would explain multiple sensitivity as well as the great variety of results in the different published series.

SUMMARY

Of one hundred cases of asthma and chronic bronchitis referred to the class, forty-four subjects were shown to be sensitive to protein. Of the forty-four, thirty-six were positive to animal emanations and of these thirty-two were positive to rabbit hair.

Sixty positive reactions were obtained. Of these forty-nine, or 81 per cent., were positive to animal emanations and thirty-two, or 54 per cent., were positive to rabbit hair.

In treating the sensitive type, removal of the protein from the environment gave marked immediate relief.

In treating the nonsensitive type, simple hygienic measures gave relief in slightly more than half the cases.

BOOK REVIEW

INDIVIDUAL GYMNASTICS. By LILLIAN CURTIS DREW.

This book should easily prove to be a useful and practical text, and should be welcomed and appreciated by both physician and educator. It fills a real need admirably, and intelligibly covers a field which is quite foreign to all but a few persons. The particular value of the book lies in the fact that it deals exhaustively with the unusual type of case and details methods and forms of treatment suitable to the individual case. This is the type of help really wanted, but only too commonly missed in the average text. All directions are concise and clear, therefore easily understood and applied. The chapters on posture are particularly good. This is fortunate in view of the fact that the subject has received considerable attention in recent pediatric literature, and is considered important. Another excellent chapter is the one on shoes and correct exercises for the feet. The style throughout the book is simple and direct. The illustrations are mostly in the form of diagrams and are fairly adequate. There are comparatively few actual photographs. The absence of these is noticeable in view of the fact that the subject matter lends itself particularly well to this form of illustration. It is probably the only shortcoming of this excellent little book.

CORRECTION

In the paper by Dr. Ludo von Meysenbug entitled "The Inorganic Phosphate Content of Breast Milk of Mothers With Normal and With Rachitic Infants" appearing in the *American Journal of Diseases of Children*, September, 1922, page 200, the last sentence of the paragraph before the summary on page 202 should read "14.8 mg. phosphorus per hundred cubic centimeters" instead of "7.4 mg."